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CLINICAL OBSERVATIONS ON AMALGAMS WITH KNOWN PHYSICAL PROPERTIES[1]

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The purpose of this investigation is to observe the clinical behavior of amalgam fillings which have been placed in the mouth under varying controlled technics. It is common knowledge that changing the trituration time will produce widely differing expansion reactions. A short trituration, hereafter referred to as under-amalgamation, will produce more expansion in the setting reaction of amalgam than longer periods of trituration.

With the amalgam chosen for this experiment the operators perfected themselves in a technic which produced an expansion of 23 to 25 microns per cm. when the alloy was under-amalgamated. When mixed according to manufacturer's directions, it expanded 7 to 9 microns per cm. and when triturated for three minutes it contracted 2 to 4 microns per cm. *Fig. 1* shows the appearance of the 3 types of mixes. The properties which the authors drilled themselves to obtain when testing this material in the laboratory are indicated in Table I. The same technic was used in mixing and inserting the fillings in the teeth. It was anticipated that this procedure produced fillings with the same properties as obtained in the laboratory experiments.

One hundred and thirty fillings were placed in 16 adults and 15 children, 5 to 7 years of age. Thirty-six of these fillings were under-amalgamated and should have expanded approximately 25 microns per cm. Fifty-one were mixed according to manufacturer's directions, thus having an expansion of 7–9 microns, while 34 were triturated for 3 minutes and should have contracted 2–4 microns. None of the fillings were polished but were left as carved at the time of insertion. This procedure was followed in order that changes which occurred in the first 24 hours would not be lost and for the purpose of observing tarnish and discoloration as influenced by surface roughness.

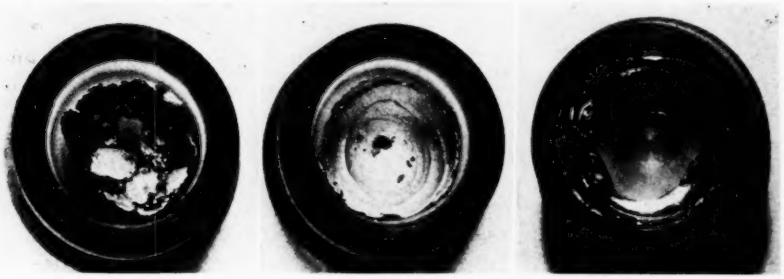
Cavity preparation was executed with great care and the rubber dam was used on all permanent teeth. Special precautions were taken to avoid contamination on restorations during packing in deciduous teeth. Special precaution was also exercised to avoid possible contamination by hand mulling.

All fillings were examined at the end of 6 months by 2 and usually 3 operators, each unaware of the other observations and of the technic employed at the time of insertion of the filling. Examinations were conducted with the aid of the mouth mirror and sharp explorer.

These observations must, of course, include the human element but efforts were made to reduce this to a minimum by taking the average of the 2 or 3 inde-

[1] Read at the 21st General Meeting of the International Association for Dental Research, Chicago, March 13 and 14, 1943. (*J. D. Res.* **22:** 202, 1943.) Received for publication March 25, 1943.

pendent observations. Usually they agreed very closely. Tarnish and roughness are easily measured but observations on dimensional change are hard to detect where dimensional changes are small and must involve personal judgment. Most of the deficiencies are very small at this stage but possibly may become more obvious as time goes on. In making these observations the term average is used as meaning the mid-point between the extremes. Charts for each restoration included remarks on preparation, occlusion, packing time, and



Under Manuf. Direct. Three Minute

Fig. 1. Appearance of 3 mixes used in this investigation. Alloy-mercury ration same in all. Difference in appearance due only to trituration time.

TABLE I

Physical properties of different mixes as determined by laboratory tests

Same properties could be anticipated in the restorations which were placed by identical technics.

OPERATOR	TYPE OF MIX	EXP.	FLOW
		μ/cm	
#1	Under	23	6.0
	Manufacturer's directions	8	2.6
	3 minute	−4	2.0
#2	Under	25	6.5
	Manufacturer's directions	9	2.8
	3 minute	−2	2.2

All specimens mixed by R. W. P.

finished restoration. All these factors are taken into consideration when the data are tabulated.

Table II shows the tabulated results of the various observations after the 6 month interval. The numerals indicate the number of fillings examined. It will be noted indications were observed that the amalgam had expanded when under-amalgamated. Conditions which were interpreted as both expansion and contraction were observed under manufacturer's directions, which produced an expansion of 7 to 9 microns per cm. Under the 3 minute mix there appeared to be more evidence of contraction than with the other technics.

In observing the remainder of the data there are only 2 sets of figures which seem to be significant. The fillings made from the under-amalgamated alloy appeared to have a high percentage with surface rougher than the average as might be expected since the particles had not been broken down in mixing. This finding also correlates with the finding that fillings made from the under-amalgamated alloy discolored more than others.

The alloy which was used in these experiments was tested for delayed expansion and the results are indicated in *fig. 2*. Curve 1 at the bottom indicates the behavior of this alloy when mixed according to manufacturer's directions by 2 operators, independently. These instructions include a slight amount of manip-

TABLE II

Observations on restorations after 6 months

	UNDER	MANUFACTURER'S DIRECTIONS	3 MINUTE
Dimensional change:			
Expansion	22	21	5
No change	13	24	19
Contraction	1	6	10
Roughness:			
Less than average	2	4	3
Average	21	39	26
More than average	13	8	5
Tarnish:			
Less than average	5	7	7
Average	19	38	25
More than average	12	6	2
Margins:			
Frail, poor	4	3	1
Average	29	45	29
Better than average	3	3	4

ulation in a clean dry hand. The amalgam will expand, however, when contaminated by saliva during packing as indicated in curves 2 and 3. Distilled water will also cause this alloy to expand as indicated in curve 4. This was true of 15 other amalgams tested which showed delayed expansion after contamination. It is our feeling that the most valuable application of the discovery of delayed expansion is not so much in the danger of excessive expansion due to contamination in mulling but in the expansion resulting from contamination by saliva during the insertion of the amalgam in the cavity.

Only 2 restorations were contaminated during packing. These were marked on the chart and were class 5 preparations on permanent teeth where contamination is difficult to avoid. One of these caused severe sharp and intermittent

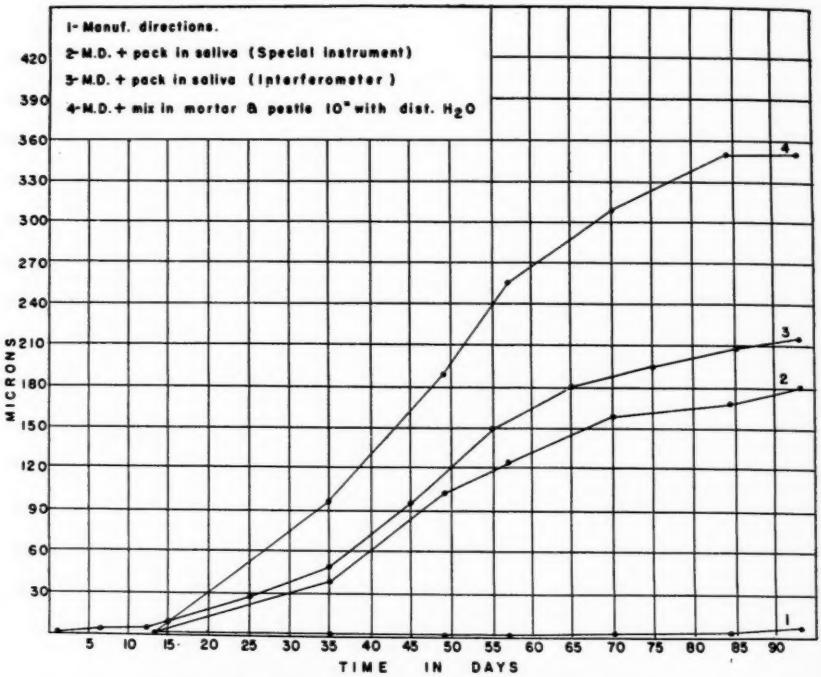


Fig. 2. Delayed expansion caused by contamination

Fig. 3. Bubble on amalgam which was contaminated during condensation

pain 3 weeks after insertion but not sooner. This was possibly due to expansion caused by contamination. On the other amalgam, a bubble appeared on the distal surface several weeks after insertion (*fig. 3*). This appears to be similar to the elevations on the surface of some specimens shown by Schoonover, Souder, and Beall, (1) in which the elevation was claimed to be caused by a chemical reaction resulting in the formation of hydrogen which produced the swelling.

CONCLUSIONS

It must be emphasized that this is only a preliminary report and too early to make conclusive statements. These restorations must be observed over much longer periods of time to be sure of these initial results. These fillings will be observed at 6 month intervals for the next 2 or 3 years. The deciduous teeth, upon extraction, will be examined for adaptation. The following observations can be recorded at this time:

1. All of these restorations, regardless of the type of mix, appeared to be superior to the average amalgam seen in the mouth and we believe this to be attributed to the use of a heavy packing pressure, proper cavity preparation with no frail enamel, and cleanliness in the handling and use of the amalgam.

2. At present there is apparently very little difference as observed clinically between an amalgam mixed according to manufacturer's directions and the 3 minute mix. There is, if anything, a tendency for the latter to be less easily tarnished and possibly slightly better adapted. The longer triturated does tend to show an apparent slight contraction in some cases but as yet that has not produced any cause for alarm.

3. The under-triturated amalgams show expansion in the mouth which is not caused by contamination. This has not been great enough to give difficulty at this early stage. However, these amalgams do tarnish more and are rougher than either of the other 2 types of mixes.

4. It is, therefore, difficult to ascertain whether the 3 minute mix or the one triturated according to manufacturer's directions is the better as observed clinically. Definitely though in terms of tarnish and roughness, the under-triturated is inferior.

5. In 3 instances patients reported pain several hours after the restorations had been completed. This information was submitted voluntarily as it was believed that any questions on this point directed at each patient would be misleading. In all 3 cases, the amalgam had been undertriturated. Whether the pain was due to trauma, expansion, or some other factor, we cannot say for sure with the limited data (2).

6. Several severe cases of tarnish were observed opposite gold inlays. On one 3 surface amalgam the mesial side was adjacent to an inlay and was badly corroded whereas the distal side was untarnished. This is of interest in connection with the work by Souder and Schoonover on corrosion of dental alloys (3). In all cases where the tarnish was observed opposite metal the data is omitted.

7. The dimensional change and any other discrepancies are so small on most

of these restorations that they would not be detected in the casual observation. Probably if all restorations had been polished, they would appear identical except for a possible higher degree of tarnish on the undertriturated amalgams.

The authors wish to express their appreciation to the Indianapolis Public Health Nursing Association and to Miss Alice Krick for their kind assistance in this investigation.

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(2) Romnes, A. F., and Skinner, E. W., *Northwestern University Bulletin*, **38:** 19, 1938.
(3) Souder, Wm., and Schoonover, I. C., *J. A. D. A.*, **28:** 1278, 1941.

A STUDY OF FLUORIDE DOMESTIC WATERS AND DENTAL CARIES EXPERIENCE IN 263 WHITE ILLINOIS SELECTIVE SERVICEMEN LIVING IN FLUORIDE AREAS FOLLOWING THE PERIOD OF CALCIFICATION OF THE PERMANENT TEETH[1]

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An inverse relationship between fluoride content of the public water supply and dental caries experience has been demonstrated among children continuously using such waters throughout life (1). A similar relationship has also been reported (2) in a white adult male population of 2,026 white selectees living in 91 Illinois communities whose public water supplies contained fluorides of different concentrations. These latter observations were divided into 2 major groupings consisting of (a) those who continuously used the public water supplies of varied fluoride content throughout life, and (b) those whose continuous exposure included the first eight years of life only.

PRESENT STUDY

As it seems apparent from these studies more protection is noticeable from the "entire life" exposure than from the "first 8 years;" and since it has been found in rats (3) that fluoride is retained by dental tissue following tooth eruption, and that such secondary fluoride deposits are apparently caries inhibiting, a further study was made of 549 white selectees living in 32 Illinois communities (Table I) whose public water supplies contained fluorides of different concentrations. For purpose of classifications these selectees were grouped into two divisions: (a) Those living in fluoride-free areas their entire lives which in this particular study is limited to domestic waters obtained from either Lake Michigan or the Mississippi River. (b) Those living in fluoride areas from 1 to 24 years following the period of calcification of the permanent teeth and not in a fluoride area the first eight years of their lives, thus calcifying their teeth on fluoride-free waters.

In this paper, therefore, "fluoride-free areas" are defined as those communities whose public water supplies contain fluorides 0.0–0.1 p.p.m.[2] range, and "fluoride areas" 1.0 p.p.m. or over.

All selectees were examined by dental examiners on the local draft boards *before the dental requirements were relaxed.* Examinations were recorded on the new dental examination work sheet developed by the Division of Dental Health Education, Illinois State Department of Public Health, in cooperation with the Selective Service System (4).

The same methods used in the study of the 91 cities in the State of Illinois with respect to public water supplies, age, color, continuity of exposure, and

[1] Received for publication March 18, 1943.

[2] P.p.m., parts per million.

other epidemiological factors discussed in detail in that report were followed in the study of the 32 communities which form the basis of this paper.

TABLE I

Analytical and Geological Data on Public Water Supplies in 32 Illinois Municipalities

MUNICIPALITY	COUNTY	POPULATION 1940	FLUORIDE (F) CONTENT IN P.P.M.	PRINCIPAL AQUIFERS
Abingdon	Knox	3,218	2.2	St. Peter, Cambrian
*Alton	Madison	31,255	0.0	Mississippi River
Aurora	Kane	47,170	1.0	Niagaran, St. Peter
*Belleville	St. Clair	28,405	0.0	Mississippi River
*Berwyn	Cook	48,451	0.0	Lake Michigan
Bradley	Kankakee	3,689	1.1	Niagaran, St. Peter
Bushnell	McDonough	2,906	4.0	St. Peter
Canton	Fulton	11,577	2.1	St. Peter
Chenoa	McLean	1,401	2.2	St. Peter
*Chester	Randolph	5,110	0.0	Mississippi River
*Dolton	Cook	3,068	0.0	Lake Michigan
East Moline	Rock Island	12,359	1.5	St. Peter
*East St. Louis	St. Clair	75,609	0.0	Mississippi River
Elmhurst	Du Page	15,458	2.0	St. Peter, Cambrian
*Evanston	Cook	65,389	0.0	Lake Michigan
Galesburg	Knox	28,876	1.9	Dresbach
Galva	Henry	2,812	1.9	St. Peter, Niagaran
*Glencoe	Cook	6,825	0.0	Lake Michigan
*Granite City	Madison	22,974	0.0	Mississippi River
Joliet	Will	42,365	1.4	St. Peter, Dresbach
Lemont	Cook	2,557	1.4	St. Peter, Dresbach
Lyons	Cook	4,960	1.0	St. Peter, Niagaran, Cambrian
*Moline	Rock Island	34,608	0.0	Mississippi River
Monmouth	Warren	9,096	1.7	St. Peter, Cambrian
*O'Fallon	St. Clair	2,407	0.0	Mississippi River
Oglesby	La Salle	3,938	1.0	Niagaran, Dresbach
*Quincy	Adams	40,469	0.0	Mississippi River
Riverside	Cook	7,935	1.8	St. Peter, Dresbach, Cambrian
*Rock Island	Rock Island	42,775	0.0	Mississippi River
*Waukegan	Lake	34,241	0.0	Lake Michigan
*Winnetka	Cook	12,430	0.0	Lake Michigan
Zion	Lake	6,555	1.2	Niagaran, St. Peter

* Control municipalities.

CLASSIFICATION OF DEFECTS AND RATES (5)

In computing an index to show the amount of dental caries in these population groups it was decided to express the amount of dental caries in terms of dental caries experience; for example, *untreated dental caries* means teeth that were carious but could be restored; *extractions indicated* applies to all broken-down teeth, roots, and unrestorable teeth; *filled teeth* applies to all filled teeth free from carious lesions; *missing* applies to teeth that had been extracted because of

dental caries; *no caries experience* applies to all teeth present with no caries experience. In computing this index no single tooth is counted more than once even though one surface may show a carious lesion and another a filling.

When it is desired to express the dental caries experience in terms of a rate per 100 selectees, the sum of the first 4 aggregates referred to is divided by the number of selectees examined and the quotient multiplied by 100. Present dental caries experience is determined by totaling the number of teeth with untreated dental caries and extractions indicated (irrespective of the number of defects per tooth). Past dental caries experience is determined by totaling the number of filled and missing teeth. The total caries experience (present and past) is determined, then, by totaling the number of teeth with untreated dental caries, extractions indicated, filled, and missing.

These rates are computed on a tooth population of 28 teeth. The third molars are omitted since there are so many variations in this tooth not connected with dental caries, such as congenitally missing and extracted because of malposition, that its inclusion would be of doubtful validity.

CLINICAL FINDINGS

Table II shows the dental caries experience of 263 selected white selectees who had lived where the public water supply contained 1.0 p.p.m. or more fluorides (F) from 1 to 24 years following the period of calcification of the permanent teeth. Table III shows the dental caries experience of 286 white selectees who were born and had lived their entire lives in municipalities in fluoride-free areas. The limited sample in all groups made it necessary to classify by intervals in years and age grouping instead of single years and ages. The selectees who have lived in fluoride areas following the period of calcification of the permanent teeth have an untreated dental caries rate of 33 less; filled rate of 161 less; extractions indicated rate of 18 less; missing rate of 30 less; and no caries experience of 241 more than those living in areas where the public water supplies are fluoride free.

When these rates are combined as present and past the two groups compare as follows: the selectees living in fluoride areas following the period of calcification of the permanent teeth have a present rate of 199 and a past rate of 639, while the selectees living in fluoride-free areas have a present rate of 249 and a past rate of 830. The total dental caries experience for these groups may be compared as follows: the selectees living in fluoride areas following the period of calcification of the permanent teeth have a total rate of 838 as compared with 1,079 for the selectees who had lived in fluoride-free areas their entire lives.

Table IV shows the dental caries experience of 454 selected white selectees who were born and had lived their entire lives in municipalities where the public water supplies contained 1.0 p.p.m. or more of fluorides (F) (2).

Table V compares and combines the dental caries experience rates of the 2 area groups (fluoride free and fluoride) and selectees who were born and had lived their entire lives in municipalities where the public water supplies contained 1.0 p.p.m. or more fluorides (F). Here we find the rates of selectees

TABLE II

Summary of dental caries experience, permanent teeth (excluding third molars) of 263 selected 21–37 year old white selectees of 17 cities, living where the public water supply contains 1.0 p.p.m. or more fluorides (F) from 1 to 24 years following the period of calcification of the permanent teeth (first eight years)

NUMBER OF YEARS LIVED IN FLUORIDE AREAS	NUMBER OF SELECTEES EXAMINED	MEAN AGE IN YEARS OF SELECTEES EXAMINED	MEAN FLUORIDE CONTENT OF WATER SUPPLIES	DENTAL CARIES EXPERIENCE, PERMANENT TEETH					
				Teeth with untreated dental caries (a)	Filled teeth (b)	Extractions indicated (c)	Missing teeth (d)	No caries experience	Total (a + b + c + d)
(A) Number									
1–5	119	27.0	1.5	209	397	64	305	2,357	975
6–10	50	25.7	1.6	93	173	20	157	957	443
Over 10	94	27.0	1.7	111	335	27	314	1,845	787
Total.....	263	26.8	1.6	413	905	111	776	5,159	2,205
(B) Number per 100 selectees									
1–5	—	—	—	176	334	54	256	1,981	819
6–10	—	—	—	186	346	40	314	1,914	886
Over 10	—	—	—	118	356	29	334	1,963	837
Total.....	—	—	—	157	344	42	295	1,962	838

TABLE III

Summary of the dental caries experience, permanent teeth (excluding third molars), of 286 selected 21–37-year-old white selectees of 15 cities, living their entire lives where the public water supply is fluoride free (Lake Michigan and Mississippi River water)

AGE	NUMBER OF SELECTEES EXAMINED	DENTAL CARIES EXPERIENCE, PERMANENT TEETH					
		Teeth with untreated dental caries (a)	Filled teeth (b)	Extractions indicated (c)	Missing teeth (d)	No caries experience	Total (a + b + c + d)
(A) Number							
21–24	190	374	944	112	483	3,407	1,913
25–28	73	134	355	47	315	1,193	851
Over 28	23	34	145	12	131	322	322
Total all ages.....	286	542	1,444	171	929	4,922	3,086
(B) Number per 100 selectees							
21–24	—	197	497	59	254	1,793	1,007
25–28	—	184	486	64	432	1,634	1,166
Over 28	—	148	630	52	570	1,400	1,400
Total all ages.....	—	190	505	60	325	1,721	1,079

living in fluoride areas during the post calcification period considerably lower than those of the fluoride-free group, and the rates for the group living their

TABLE IV

Summary of the dental caries experience, permanent teeth (excluding third molars) of 454 selected 21–37-year-old white selectees of 31 cities, living their entire lives where the public water supply contains 1.0 p.p.m. or more fluorides (F)

AGE	NUMBER OF SELECTEES EXAMINED	DENTAL CARES EXPERIENCE, PERMANENT TEETH					
		Teeth with untreated dental caries (a)	Filled teeth (b)	Extractions indicated (c)	Missing teeth (d)	No caries experience	Total (a + b + c + d)
(A) Number							
21–24	252	391	577	75	359	5,654	1,402
25–28	104	144	306	37	199	2,226	686
Over 28	98	95	303	44	288	2,014	730
Total all ages.....	454	630	1,186	156	846	9,894	2,818
(B) Number per 100 selectees							
21–24	—	155	229	30	142	2,244	556
25–28	—	138	294	36	191	2,140	660
Over 28	—	97	309	45	294	2,055	745
Total all ages.....	—	139	261	34	186	2,179	621

TABLE V

Comparison of the dental caries experience rates in the permanent teeth (excluding third molars) of 286 selected white selectees living in fluoride-free areas their entire lives; 263 selected white selectees living in fluoride areas following the period of calcification of the permanent teeth; 454 selected white selectees living in fluoride areas their entire lives where the public water supply contains 1.0 p.p.m. or more fluorides (F)

NUMBER OF SELECTEES EXAMINED			TEETH WITH UNTREATED DENTAL CARIES (a)			FILLED TEETH (b)			EXTRACTIONS INDICATED (c)			MISSING TEETH (d)			NO CARIES EXPERIENCE			TOTAL (a + b + c +		
Fluoride free entire life	Fluoride area		Fluoride free entire life	Fluoride area		Fluoride free entire life	Fluoride area		Fluoride free entire life	Fluoride area		Fluoride free entire life	Fluoride area		Fluoride free entire life	Fluoride area		Fluoride free entire life	Fluoride area	
	Post calcification only	Entire life		Post calcification only	Entire life		Post calcification only	Entire life		Post calcification only	Entire life		Post calcification only	Entire life		Post calcification only	Entire life		Post calcification only	Entire life
286	263	454	197	157	139	505	344	261	60	42	34	325	295	186	1,721	1,962	279	1,079	838	621

entire lives in areas where the public water supply contained 1.0 p.p.m. or more fluorides (F) much lower than the post calcification group.

PROSTHESES AND REJECTIONS

Table VI compares the prostheses and rejections of 549 selectees living in fluoride-free areas and fluoride (F) areas following the calcification of the permanent teeth. It was found the greater percentage of prostheses as well as rejections were in the fluoride-free areas. More extensive prostheses among the fluoride-free group of selectees were also observed.

TABLE VI

Comparison of protheses and rejections of selectees living where the public water supply contains 1.0 p.p.m. or more fluorides from 1 to 24 years following the period of calification of the permanent teeth (first eight years) and those living in areas where the public water supply is fluoride free

	NUMBER OF SELECTEES EXAMINED	PROSTHESES				REJECTIONS							
		Crowns and bridges		Dentures (full and partial)		Qualified for limited military service				Disqualified for military service			
						Dental		Both dental and medical		Dental		Both dental and medical	
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Selectees living in fluoride - free areas their entire lives.....	286	35	12.2	12	4.2	10	3.5	0	0.0	5	1.7	0	0.0
Selectees living in fluoride areas 1 to 24 years after calcification of teeth.....	263	20	7.6	8	3.0	3	1.1	0	0.0	4	1.5	0	0.0
Selectees living in fluoride areas 1 to 5 years after calcification of teeth.....	119	10	8.4	1	.8	1	.8	0	0.0	2	1.7	0	0.0
Selectees living in fluoride areas 6 to 10 years after calcification of teeth	50	3	6.0	3	6.0	2	4.0	0	0.0	0	0.0	0	0.0
Selectees living in fluoride areas 11 to 24 years after calcification of teeth.....	94	7	7.4	4	4.3	0	0.0	0	0.0	2	2.1	0	0.0

TESTS FOR SIGNIFICANCE (6)

Calculating the standard error of the difference between the caries experience of the two groups studied by means of the formula $\sqrt{\frac{P \times Q}{N_1} + \frac{P \times Q}{N_2}}$, we find that the difference in caries experience between the selectees who have lived their entire lives in areas where the water contained no fluoride (F) and those who have lived in fluoride areas following the calcification of the permanent

teeth is 11.3 times the standard error. A difference of 3 standard errors is considered significant. From these figures, we may say, that the difference in dental caries experience of selectees living in fluoride-free and fluoride areas following the calcification of the permanent teeth is almost certainly due to some factor other than chance.

AGE DISTRIBUTION

Since age distribution of the groups compared varied, the average ages were computed. For those living their entire lives in fluoride-free areas, the average age was 23.9 years, while for those living in fluoride areas following the calcification of the permanent teeth it was 26.8 years. Since the average age of the fluoride-free group was less than that of the fluoride area, we would expect the difference in caries experience to be even larger if the average ages were equal.

CONCLUSIONS

A study of 549 white adults lends further support to the fluorine dental caries hypotheses. The domestic waters used by these selectees were grouped into two broad divisions, *fluoride-free* (0.0–0.1 p.p.m. of F), and *fluoride* (1.0 p.p.m. and over). Individuals were classified according to whether they had used the domestic water in question (a) during their entire life, or (b) following the calcification of the permanent teeth (first 8 years). A lower dental caries experience and a higher rate of teeth with no caries experience was observed in those using fluoride water following the calcification of the permanent teeth when compared with those using fluoride-free domestic waters.

Other factors being essentially the same it is reasonable to assume that the marked difference in dental caries experienced by the two groups is attributable to the differences in the fluoride content of the domestic waters used, and indicates that fluoride (F) has an inhibitory effect on dental caries after the calcification of the permanent teeth.

Attention is also called to the lower percentage of selectees rejected for military service because of dental condition, and the lower percentage using various forms of dental prostheses in those selectees from the fluoride water area.

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AVERAGE WEIGHTS OF THE PERMANENT TEETH, INCLUDING THE RELATIVE AMOUNTS OF ENAMEL TO DENTIN AND CEMENTUM[1]

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Average measurements of the human teeth, which were determined by G. V. Black (1), have been standard data available in textbooks for many years. A review of the dental literature, however, does not disclose a study of the weights of the permanent teeth. Occasional reports have been published, but these do not present a sufficient number of weights on each tooth type to allow the establishment of average figures. The present study was designed to provide such data.

Following the determination of the individual tooth weights, representative specimens were selected, grouped according to tooth type, and separated into (a) enamel and (b) dentin and cementum portions. These fractions were then weighed. Such data is likewise provided in the present study.

PROCEDURE

From approximately 500,000 teeth extracted by dentists in various localities throughout the state of Indiana, 759 sound specimens, representing the 32 permanent types, were selected. It is believed that by following such a procedure of selecting the teeth, it can be assumed that the teeth are representative of the inhabitants of this country at large. The weights of the different varieties differed, but in all types the number of individual weights was sufficient to insure reasonable accuracy as to the average weight. With a greater number, both larger and smaller teeth undoubtedly might be found, but the occurrence of such teeth must be rare and perhaps should be classified as anomalies.

Only those teeth were used for this study which conformed to normal anatomic form and exhibited a minimum amount of wear. In all cases the roots were completely formed; those with excessive amounts of secondary cementum were not used. Prior to weighing, each tooth was carefully cleaned by scraping off the adherent periodontal membrane, calculus, and other debris. The tooth was brushed lightly with pumice and water and wiped with a soft cloth. At no time following the removal of the teeth from the oral cavity were they allowed to dry out. After being thoroughly cleaned, all of the teeth were placed in a humidifier maintained at constant temperature. Quantitative weighings were performed at frequent intervals in air-tight weighing bottles until the moisture content of each tooth attained an equilibrium. The final weights were recorded.

Separations of enamel from dentin and cementum were performed according

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to the method of Manly and Hodge (2). From 8 to 10 teeth of each type were pooled for each separation sample with all separations done in duplicate. Following this, enamel and dentin and cementum sample were again placed in the humidifier and allowed to regain a constant weight. Loss in weight as a result of the separation was negligible in most instances. The loss that did occur was assumed to be equally distributed between the separated fractions and the corresponding expressions corrected. It was not possible to determine the weight of

TABLE I

Average weights of permanent teeth

TOOTH	NUMBER OF TEETH	AVERAGE MOIST WEIGHT	RANGE	STANDARD DEVIATION
		grams		
Upper:				
1st incisor	51	1.1917	0.8652–1.6211	0.1726
2nd incisor	51	0.8171	0.5208–1.1655	0.1190
Canine	51	1.2821	0.8526–1.8435	0.2188
1st Premolar	51	1.2283	0.8970–1.7556	0.2334
2nd Premolar	54	1.1266	0.8726–1.3845	0.1405
1st Molar	40	2.4830	1.9840–3.1845	0.3020
2nd Molar	54	2.1780	1.4100–2.9125	0.3324
3rd Molar	53	1.7323	1.0733–2.4395	0.3205
Total	405	12.0391		
Lower:				
1st incisor	55	0.5494	0.2995–0.7827	0.0810
2nd incisor	49	0.6326	0.4429–0.9290	0.0854
Canine	41	1.0945	0.7495–1.6194	0.1869
1st Premolar	49	0.9712	0.7326–1.3882	0.1443
2nd Premolar	54	1.0934	0.7946–1.5124	0.1550
1st Molar	38	2.3175	1.7770–3.1788	0.3276
2nd Molar	42	2.2656	1.5054–2.9000	0.3184
3rd Molar	26	1.9891	1.5136–2.8132	0.2887
Total	354	10.9133		
Both arches	759	22.9524		

the pulp tissue. Presumably it was removed with the dentin and cementum fractions where it assumed a relatively unimportant part of the total amount.

RESULTS

The total number of teeth examined for each type and their average moist weights are given in Table I. Likewise, the range, i.e., the weight of the lightest tooth as contrasted to the heaviest in each group, is presented. In this connection, it is of interest to note that the largest figure is approximately twice the smallest figure for each tooth type examined.

Upon further inspection of the table, it is seen that the lower first incisor

weighs the least of any tooth in the oral cavity; the upper first molar has the greatest weight. The weights of the other teeth fall between these extremes. The upper canine is heavier than the lower canine and the canine in either jaw is heavier than the premolars in that jaw. The upper first molar is heavier than the lower, but the lower second molar as well as the lower third average more than their corresponding teeth in the upper arch.

Summary figures disclose 22.9524 grams of tooth substance in the average

TABLE II

Relative weights of enamel to dentin and cementum

TOOTH	ENAMEL	PER CENT	DENTIN AND CEMENTUM	PER CENT	RATIO
Upper:					
1st incisor	0.2624	22.02	0.9293	77.98	3.54
2nd incisor	0.1740	21.30	0.6431	78.70	3.70
Canine	0.2822	22.01	0.9999	77.99	3.54
1st Premolar	0.2785	22.67	0.9498	77.33	3.41
2nd Premolar	0.2189	19.43	0.9077	80.57	4.15
1st Molar	0.5907	23.79	1.8923	76.21	3.20
2nd Molar	0.4461	20.48	1.7319	79.52	3.88
3rd Molar	0.4036	23.30	1.3287	76.70	3.29
Total	2.6564	22.06	9.3827	77.94	3.53
Lower:					
1st incisor	0.0696	12.67	0.4798	87.33	6.89
2nd incisor	0.1191	18.83	0.5135	81.17	4.31
Canine	0.1362	12.44	0.9583	87.56	7.04
1st Premolar	0.1647	16.96	0.8065	83.04	4.90
2nd Premolar	0.3234	29.58	0.7700	70.42	2.38
1st Molar	0.5068	21.87	1.8107	78.13	3.57
2nd Molar	0.5913	26.10	1.6743	73.90	2.83
3rd Molar	0.5201	26.15	1.4690	73.85	2.82
Total	2.4312	22.28	8.4821	77.72	3.49
Both arches	5.0876	22.17	17.8648	77.83	3.51

adult dentition, of which 12.0391 grams are in the upper arch and 10.9133 grams are in the lower.

Table II presents the relative weights of enamel to dentin and cementum. The per cent of each fraction as well as the ratio of one to the other, assuming enamel as a figure of 1, are also expressed in this table. The lower first incisor contains the least amount of enamel as compared to other teeth. Likewise the relative amount of dentin is high in this tooth (ratio, 6.89), but not as high as for the the lower canine (ratio, 7.04). The lower second molar contains the greatest amount of enamel. The tooth in the mouth which contains the greatest amount of enamel in porportion to the dentin is the lower second premolar

(ratio, 2.38). Summary figures disclose a total of 5.0876 grams of enamel and 17.8648 grams of dentin, i.e., a ratio of 1 to 3.51, for the entire dentition. There is no marked difference in the ratio of weights for the upper teeth as contrasted to those of the lower.

SUMMARY AND CONCLUSIONS

The data presented in this report furnish a standard basis for the weights of the 32 permanent teeth as well as the total average amounts of enamel and dentin and cementum. A detailed tabulation of the weights as well as summary figures are presented in the tables. One of the uses that can be made of such data is that of serving as the basis for various computations involving expressions as to the total amount of organic and inorganic material in the adult dentition. Moreover, such data can serve as a substantial basis for comparisons of relative tooth size among various races. We intend to use the data as a measure of the relative loss of enamel which occurs following the immersion of this portion of the tooth in various solubility fluids. Such experiments are now in progress.

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DEVELOPMENT AND PHYSIOLOGIC PURPOSE OF THE ORGANIC MATTER OF ENAMEL[1]

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LITERATURE

In 1878 C. F. W. Bodecker (1) described the organic matter of the enamel as enamel fibres and in 1890 von Ebner (2) described the organic interprismatic substance with the understanding that it cemented together the calcified enamel prisms. Later C. F. W. Bodecker (3) and C. F. Bodecker (4) described the prism sheaths, the tufts and lamellae of the enamel, and published photomicrographs of these structures. They considered these structures to be channels for fluid circulation in the enamel. Gottlieb (5) described cracks in the calcifying enamel into which surrounding tissue has penetrated and died after tooth eruption and thereby explained the extension of some lamellae into the dentin. Orban (6) showed prism groups remaining in the matrix stage and creating a source for the development of another kind of lamella.

Fish (7) succeeded in intravitam staining of prism sheaths of enamel in dogs by sealing solid methylene blue into the pulp chamber for 24 hours. According to Diamond and Weinmann (8) the matrix is constructed entirely before maturing calcification sets in and mature enamel is characterized by its solubility in acid. Kitchin (9) previously indicated similar results. Weinmann, Wessinger and Reed (10) found that the organic content of enamel before maturation is about 30% compared with about 5% in mature enamel.

Orban (11) showed by photomicrographs that the periphery of the prism calcifies first, the center remaining uncalcified. According to Orban, von Ebner described the formation of enamel in the following way: at the dentinal ends of the ameloblasts a homogeneous mass develops, which does not show any differentiation into prisms. The prisms differentiate later. Nevertheless von Ebner believed, as have other authors, that every ameloblast forms one prism and he explained the peculiar course of some prisms by a change of the position of the ameloblasts.

Saunders, Nuckols and Frisbie (12) described the dentino-enamel membrane which is supposed to fix the enamel to the dentin. They showed that, like in dentin and bone, a non-calcified pre-enamel is formed, which undergoes later calcification.

FINDINGS

During the formation of the enamel matrix the thin layer last deposited on the dentin is characterized by peculiar features. It seems to be glued to the dentin;

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in contrast to the older matrix it seldom becomes separated from the dentin by shrinkage. *Fig. 1* shows a tooth germ with enamel in the matrix stage. The thin cervical ends of the enamel are in close contact with the dentin but in nearly all other parts of the specimen these tissues are separated by shrinkage

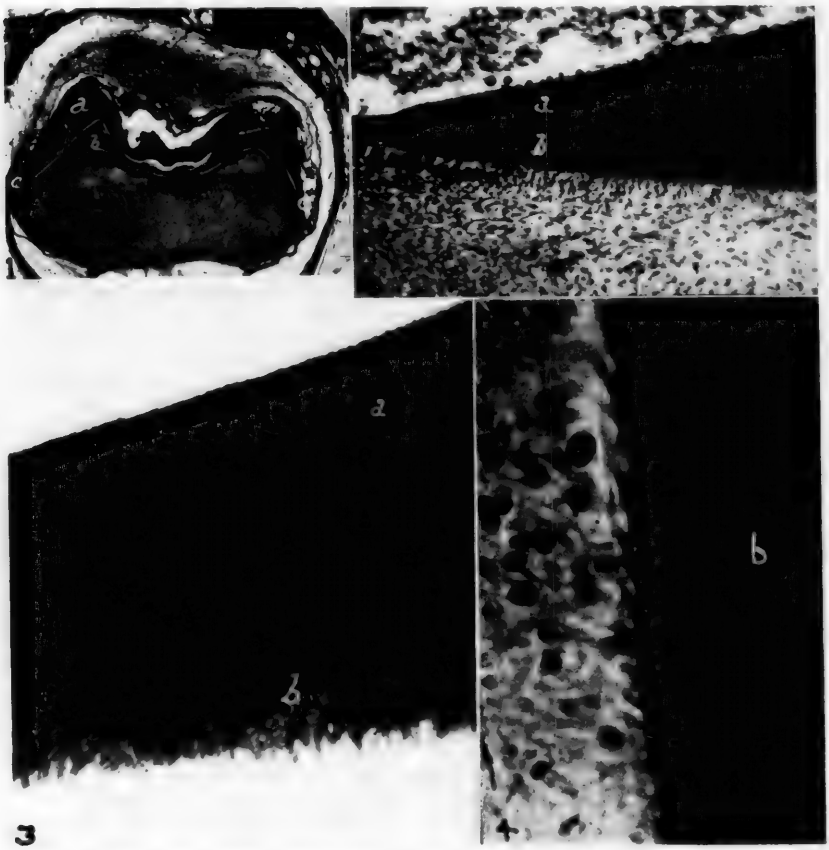

FIG. 1. Human tooth germ, decalcified. Most parts of enamel matrix (a) shrunk away from dentin, (b) two freshly deposited cervical ends, (c) maintain their contact with dentin.

FIG. 2. Higher magnification of freshly deposited end of matrix (a) on dentin (b).

FIG. 3. Thicker layer of matrix. Latest deposited parts (a) look homogeneous. Older parts (b) are differentiated into prisms.

FIG. 4. Young enamel matrix. Uncalcified centres have been torn out with ameloblasts. Periphery remained as homogeneous honey-comb network (a). Older part (b) is already homogeneous mass.

of the matrix. *Fig. 2* shows a higher magnification of such a thin layer of matrix. It is closely adapted to the dentinal surface, whereas the older part, nearby, shows a slight separation from the dentin. Like all other freshly deposited enamel, it is darkly stained with hematoxylin and individual prisms

are not discernible. *Fig. 3* shows a thicker layer of enamel matrix. In the peripheral, last deposited area the matrix is homogeneously dark; individual

Fig. 5. Enamel matrix (a) partly shrunken away from dentin (b). Separated surfaces of both tissues are smooth.

Fig. 6. Enamel matrix separated from dentin by shrinkage. One part of dentin surface (a_1) is smooth. Adjoining part (a_2) shows fibres attached, which have been torn out from matrix.

Fig. 7. Enamel partly dissolved by acid (a), partly in matrix stage (b). Matrix shrunk away from dentin remaining in connection with detached dentino-enamel membrane (c).

Fig. 8. Decalcified, erupted deciduous tooth. Prisms have been dissolved (a). Numerous fibres of enamel, resisted acid action and remained attached to dentin (b).

Fig. 9. Decalcified, erupted permanent tooth. Enamel (a) has been dissolved. Enamel fibres partly isolated (b) partly in groups (c) remained attached to dentin (d).

prisms can easily be identified in the older part. They are separated by the prism sheaths which retained the original dark stain. The prisms became lighter staining, apparently by additional calcification. Some prism groups can be seen crossing others.

Fig. 4 shows freshly deposited enamel matrix in honeycomb form. This is explained by the fact that the parts of the matrix corresponding to the periphery of the ameloblasts are formed and calcified prior to the central parts. As long as the prisms are not calcified they remain connected to the ameloblasts (Tomes processes) and show up as empty spaces when the Tomes processes are torn out. The remaining honeycomb portion is homogeneously blue and individual prisms at that stage are not yet differentiable.

Fig. 5 shows the enamel matrix separated from the dentin by shrinkage and that both separated surfaces are smooth. In *Fig. 6* another part of the same tooth shows the matrix separated from the dentin, but on one end a smooth surface is found while on the other end fibres are torn out from the matrix attached to the dentinal surface. *Fig. 7* shows dissolved mature enamel with only a small part still in the matrix stage. Shrinkage separated that part, together with a continuous membrane, from the dentin. A layer of fibres of the mature part is connected with the membrane, apparently the dentino-enamel membrane of Saunders, Nuckols and Frisbie.

Figs. 8 and *9* show dentinal surfaces of decalcified teeth with mature enamel. In *Fig. 8* (deciduous tooth) a row of acid resisting enamel fibres which remained in connection with the dentin after dissolution of the calcified part is seen. *Fig. 9* (permanent tooth) illustrates numerous enamel fibres which remained connected with the dentin after loss of the calcified part of the enamel by decalcification. These are partly prism sheaths. Other parts are more densely arranged and suggest the tufts of ground sections.

COMMENTS

The ameloblasts border the odontoblasts with a definite line. The dentinal papilla starts deposition of dentin on the inner surface of the ameloblasts. Here the outline of the ameloblasts determines the future outline of the dentino-enamel junction (Erdheim).

At the time of the first deposition of enamel matrix, when the tissue contains the most organic matter, a union of the whole tissue takes place. The dentino-enamel membrane (*fig. 7*) seems to play a role in the fixation. The newly formed parts of the matrix do not detach from the dentin, while the older neighboring parts are found detached (*figs. 1* and *2*). The progressing calcification in the prism parts of the matrix (*fig. 3*) weakens the attachment and only the more organic parts of the enamel which resist calcification, the prism sheaths, maintain their connection with the dentin (*fig. 6a*$_2$). The smooth surfaces of the enamel and dentin, in detaching by shrinkage of the young matrix, indicate an entire separation of these 2 tissues (*fig. 5*, *6a*$_1$). The attachment of the whole matrix to the dentin was weaker than the force produced in shrinking of the matrix during preparation of the specimen.

The power of attachment of the noncalcified parts of the enamel seems to increase as time goes on. In the same tooth there may be places where a smooth separation between enamel and dentin occurred, while nearby fibres of the matrix, torn out from between prisms, remained in connection with the dentin. At such places the fixation of the organic fibres of the matrix to the dentin was stronger than their fixation to the surrounding enamel matrix (*fig. 6*).

In the shrinkage of a partly mature matrix (*fig. 7*), a continuous membrane, with attached fibres, is found detached from the dentinal surface. This is apparently the dentino-enamel membrane of Saunders, Nuckolls and Frisbie. It remains in the matrix stage, like the fibres between the prisms, and seems to have the purpose of fixing the enamel to the dentin as suggested by Saunders, Nuckolls and Frisbie. It apparently is the first means of fixation of the freshly formed matrix to the dentin. At the time of the early formation of the fibres, they are attached to the membrane. No indication of its presence as a separate structure was found in later stages. Possibly it unites with the dentin and cannot be discerned. The fibres of mature enamel seem to be attached directly to the dentin.

If teeth with mature enamel are carefully decalcified a brush of fibres attached to the dentin surface, with the calcified prisms between them dissolved by acid, is found. On non-erupted teeth these fibres are present all over the dentin. In erupted teeth they are often lost at free areas, being traumatized in the process of histological preparation, but remain in those parts which are protected by gingival flaps. These fibres, which are partly isolated and arranged in groups, apparently fix the enamel to the dentin.

The enamel lamellae apparently have no physiological purpose. They are products of particular developmental conditions. However, together with the other organic matter in the enamel, they may play an important role in the developing and spreading of dental caries. The fact that some fluid circulation has been shown to exist along the prism sheaths may show that these small bits of organic matter have their physiological purpose.

The prisms do not always follow parallel courses from the outer enamel surface to the dentin. In thick layers of enamel, some of these prism groups can be observed to follow tortuous courses, especially in the middle and sometimes in the dentinal part. The twisted courses can not be brought into harmony with the concept that each ameloblast always forms one prism from the beginning to the end. The literature states that in the freshly formed enamel matrix individual prisms cannot be discerned, a finding supported by *figs. 2* and *3*. The rods emerge from a homogeneous mass some time afterwards. Saunders, Nuckolls and Frisbie showed that each ameloblast forms a corresponding part of pre-enamel. The first calcification brings these different parts nearer to a homogeneous mass, apparently by homogeneous calcification of the whole pre-enamel at the time of the first calcium deposition. Additional calcium deposition into the matrix differs in different parts, calcium salts being deposited more in some places and less in others. The prism sheaths, being less calcified, retain their dark staining corresponding to the early matrix stage while the more

highly calcified prisms become lighter staining. This differentiation makes the individual prisms, separated by the darker stained sheaths, clearly visible. In many places differentiation is influenced by prearranged separation from the pre-enamel stage. In some places the early matrix became quite homogeneous and crystallization takes place in a free area, the individual products being shaped according to the neighboring prism forms.

SUMMARY

The organic fibres of the prism sheaths and tufts are those parts of the enamel which remain in the early matrix stage, resisting acid action. These organic fibres fix the prisms to each other, and the enamel to the dentin.

The peculiar course of prism groups in some parts render improbable the concept that each prism is formed by one ameloblast in its entire length. It is suggested that in such areas the rods are crystallization products of the homogeneous mass of early matrix formation.

Four phases in enamel formation must be differentiated: First, the uncalcified pre-enamel formation (Saunders, Nuckolls and Frisbie); secondly, the first calcification resulting in the formation of the homogeneous matrix; thirdly, differentiation of the prisms in the matrix stage by additional calcification of the prisms; fourth, the final maturation of the enamel (Diamond and Weinmann).

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Washington University, St. Louis, Mo.

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I. Address of Retiring President

Charles F. Bodecker, D.D.S., Columbia University, School of Oral and Dental Surgery, New York, N. Y.

It is customary that the address of the retiring president should be brief. This restriction is even more appropriate at this time as the present meeting is the combined event of the Omicron Kappa Upsilon Honorary Fraternity and the International Association for Dental Research.

A few outstanding activities of the past year must be brought to the attention of the Association. The first of these was mentioned by Dr. Schour, president of the Association in 1941–1942. He recommended that the South American

[1] The sessions of the International Association for Dental Research preceded, by agreement, the Annual Meeting of the American Association for Dental Schools, in the same hotel, March 15–17. The members of each body were welcome at, and participated in, the sessions of both Associations. The annual informal dinner, served to 106 members and guests, preceded the concluding session on the evening of March 19. This dinner and the concluding session were held jointly with Omicron Kappa Upsilon and W. H. Wright, president of Omicron Kappa Upsilon, presided.

[2] The General Secretary of the Association, E. H. Hatton, has rendered invaluable assistance to the Editor of the Association in preparing these proceedings.

republics be contacted so as to found new sections of the I.A.D.R. Present world conditions, however, and the difficulty of correspondence have made it impossible to consumate this objective.

The promise that fluorine will prove to be a means of reducing or even preventing dental caries has been followed. There are a number of methods of applying fluorine as a caries prophylaxis: through the general water supply, in natural foods such as milk, or by topical application to the teeth. The last mentioned method has been publicized in the daily press, resulting in the premature demands of patients for such treatment. Observations are being made in a number of institutions to note the efficacy of topical fluorine application as a caries preventive. Significant data showing benefical results of this therapy have been presented.

Some members of the I. A. D. R. have been very much perturbed concerning the subject of research on commercial products and the possibilities that the Journal is being used for commercial purposes. There is no doubt that some commercial products require investigation in order to protect the public against unjust claims and also to assist manufacturers who are in search of the truth about their products. The recent unfortunate discussion has brought the subject of research on commercial products to a head. This discussion proves the often observed fact that scientists are notoriously poor business men and conversely that business men do not understand the ways of scientists. It just seems that research and business are as far apart as the two poles.

But to return to research on commercial products. This activity is essential to the protection of the public. If manufacturers are honest in their desire to know the truth about their products, research men should give them complete cooperation. The difficulty is to control the advertising departments of manufacturing firms. The former, being responsible for the successful marketing of the products, publicize only *favorable* opinions but disregard any adverse criticism, thus misleading the public. As a further result, investigators who report on such products, as well as the universities in which they are employed receive distasteful publicity. Steps should be taken by the Association to formulate rules which may be used as a guide in setting up research projects on commercial products.

The problem of abrasive dentifrices is much before the public's attention. Advertisements frighten readers with the grave danger of harming the teeth with gritty tooth powders or pastes. Pictures in weekly journals show that "cavities" form as a result of using an abrasive dentifrice. Some of the audience tonight may possibly say, "What has that to do with research and the activities of a research organization"? The fact is that this subject is important because one of the prime aims of research is to discover the truth and protect the public. If manufacturers, even though honestly believing their own statements, are scaring the public to use only their product, it is the duty of research men to learn the truth. Abrasion is admittedly due to gritty dentifrices and an incorrect method of brushing the teeth. But the *purpose* of advertising non-

abrasive dentifrices is to scare the public; they imply that the "cavity" formation is really serious. All dentists know that in only the rarest instance is a tooth lost as a result of cervical abrasion. Further, the problem of abrasion is not completely solved; gritty dentifrices do not seem to be the only factor in this type of tooth destruction. Our investigations suggest that an acid may be a predisposing cause of abrasion or of erosion.

The duty of researchers in this particular case is clear. In order to protect the public and not have it forced to buy a particular product, the truth must be determined and publicized.

In closing, I wish to thank the officers of the Association for their excellent cooperation and the Local Arrangements Committee for the thorough preparation for the present meeting. Dr. Hatton, our worthy secretary, has functioned well in spite of added responsibilities. The attendance at the scientific sessions was unexpectedly large considering the present world conditions. The interest shown in our meetings emphasizes the importance of research, even in these grave times. All we, as researchers, have to remember is to "pull together," to forget institutional jealousies. The principal purpose of research in dental fields is to relieve the nation of dental caries, periodontoclasia and erosion; and for this purpose investigators of the entire nation should pool their thoughts, their energies and resources.

II. Introduction of the President Elect

Russell W. Bunting, D.D.S., School of Dentistry, University of Michigan, Ann Arbor, Mich.

Dr. Bunting, a former president of the association, inducted the active officers, all of whom were present, to accept the positions to which they had been elected. The script of the official ceremony served only as a foundation for the spontaneous, very informal and wholly enjoyable transfer of the administration from the old to the new official family. Dr. Bunting pleaded embarrassment in presenting Philip Jay as the incoming president because of his long and familiar association with Dr. Jay as a research colleague and staff member in the School of Dentistry at the University of Michigan, but only because praise due his younger associate might seem somewhat immodest, and capable of misinterpretation to that extent.

This association with Dr. Jay seemed but a very short time looking backward, but their united activities, pointed at a common objective, had really covered a considerable space of time and had represented, at least in the earlier years, a constant struggle for both financial and scientific support for the investigations in which they were literally engulfed. Whatever success had been gained as a result of this work, the speaker must attribute no small part to the help, the enthusiasm, the persistance and great ability of the incoming president of this Association. His attainments in research and institutional activity promised a harmonious and progressive administration of the affairs of the Association. It was, the speaker asserted, a very happy privilege to present his accomplished

associate to the members of the Association and to hand to him the gavel as the emblem of his authority as president of the International Association for Dental Research for the year 1943–1944.

III. Inaugural Remarks

Philip Jay, D.D.S., School of Dentistry, University of Michigan, Ann Arbor, Mich.

In accepting the presidency, Dr. Jay thanked the Association for the high honor that had been confered on him and for the faith implied by his election in his devotion to dental research and the welfare of the Association. He was very appreciative of the very kindly introduction by his chief and fellow worker, no one was more competent to pass on his worthiness, and perhaps no one was more charitable in the exercise of the privileges inherent in such an introduction.

The speaker was sure that this was not the time nor the place for a long address dealing either with problems of research in the field of dental caries, or with the past and future of the Research Association. Indeed he had been assured by the secretary-treasurer that he was under no obligation to do either and that he might limit himself to such few remarks as might seem appropriate to the occasion.

No one was more conscious of the progressive evolution of the annual meetings and the steady improvement of the quality of the program content than he, but there was, he thought, still great room for further improvement. Quality in the past had been sacrificed in part for quantity; too many items had been accepted for programs at the last minute and just prior to the delivery of the program to the printer. Early submission of items intended for the program would allow ample time for their study by an advisory group selected from the Board of Editors and other members of the Association and the creation of a program of maximum interest and logical arrangement.

In his mind many statements in current literature concerning dental caries are misleading, and especially many of those that have to do with the role of nutrition in caries control. For example both the professional and lay person, in too many instances, have been lead to expect very material results from dietary programs featuring high content of minerals and calcifying vitamins. It would seem to be one of the functions of this Association to emphasize quite emphatically the distinction between what are established facts and what are subjects that are still wholly open for further study and discussion.

In a somewhat lighter vein the speaker hoped that future programs and future meetings would be less concerned with dentifrices and tooth abrasion. Discussions and conferences about such subjects for once have been wholly out of proportion to their relative importance and to their significance in the activities of the Association. The Association will do well to assume all responsibility for what has happened in the past even though it may not be altogether happy about some of the occurrences. However, having conceded this, it should forget them but remember to conduct itself from now on so as to avoid invidious criticism.

Activity in research in all probability will be at a low level for the duration of hostilities except for those projects that may have something to do with winning the war. At all hazards the integrity of the Association must be preserved till such time as it may function usefully again. The speaker pledged the services of all the active officers to that end and to the best interests of dental research.

IV. Index of Participants, and Sequence Numerals of Corresponding Abstracts

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V. First Session: Morning; March 18; Abstracts 1–8

1. Studies in bone healing. *Warren R. Schram, D.D.S., M.S.D., and L. S. Fosdick, Ph.D., School of Dentistry, Northwestern University, Chicago, Ill.* A 2 cm. section was removed from the ulna of a dog and various procedures followed in attempts to cause bone to regenerate in such a way as to effect re-

* Guest.

pair. It was found that when synthetic bone paste was placed in the opening in such a manner as to regulate absorption, regeneration followed.

2. RATE OF VERTICAL CHANGE INDUCED BY WEARING ANTERIOR BITE PLATES. *T. D. Speidel, D.D.S., M.S., School of Dentistry, University of Indiana, Indianapolis, Ind.* The vertical changes resulting from wearing anterior bite plates by 3 boys for a period of 16 weeks were studied by means of standardized profile roentgenograms. The roentgenograms were made at approximately monthly intervals throughout the period. The amount of vertical change was determined by direct measurements on the roentgenograms from nasion to the incisal edge of the lower incisors. Measurements on the serial records showed that the distance from nasion to lower incisors increased throughout the period of study. The amount of each person's change at 4, 8, 12 and 16 week intervals was tabulated and the rates of change computed. During the first 4 weeks, each of the boys made a larger vertical change than during the second 4 week period (3.4 as compared to 1.6, 1.7 to .5, and 1.3 to .9 mm.). After this initial rapid change, there were progressively smaller changes in succeeding 4 week periods. Calculated rates of vertical change were highest during the first 4 week period (.32 to .85 mm. per week). These rates decreased throughout the period of study, the last 4 week period having rates of but .02 to .2 mm. change per week. From 47 to 55% of the total change induced by wearing anterior bite plates for 16 weeks occurred during the first 4 weeks.

3. NEW PROCEDURES FOR TESTING ABRASION OF DENTIN. *R. S. Manly, Ph.D., Ivorydale, Ohio.* Four new machines have been developed for studying dentin abrasion by dentifrice abrasives. One similar to the original equipment (*J. D. Res.* **20**: 583, 1941) permits 8 teeth to be brushed simultaneously and a shadowgraphic method to be employed in measuring cervical wear on teeth. A second design was produced to incorporate certain conveniences not found previously. With teeth selected at random the precision of the average of 8 tests amounted to 12 per cent. A third instrument was devised for brushing teeth longitudinally toward the crown, and was found to produce notches on most of the teeth brushed with abrasives. Generally the shape of the notches was more similar to certain types seen *in vivo* than to those produced by mechanical cross-brushing.

For routine testing, the most suitable instrument was found to be turntable type, but the correlation between this type and machines using whole teeth was satisfactory only when dentin blocks were used as the test objects, and the turntable was coated with nylon. When these and other precautions were observed, single tests with a precision of 5% could be performed in 15 minutes.

Tests made on samples of popular paste and powder dentifrices purchased biennially indicated a slight downward trend in the abrasiveness of these products.

4. PREVALENCE OF TOOTH ROOT EXPOSURE AND ABRASION AMONG DENTAL PATIENTS. *J. C. Ervin, Ch.E., Ivorydale, and E. M. Bucher, D.D.S., Columbus, Ohio.* A survey of the incidence of cervical exposure and abrasion among dental patients has been made by practicing dentists in 12 cities throughout the United

States. A random sample of approximately 100 dental patients over 20 years of age were examined in each city. Exposure of cementum (or dentin) was counted only if it measured more than 1 mm. from the enamel margin to the gingiva. Notches at the cervix of the teeth were judged to be abrasions only if the enamel margin was sound and the area was non-carious. They were classified according to depth from Class I (0.5 mm. or less) to Class IV (greater than 1.5 mm.). Results of the examinations showed that tooth root exposure of one or more teeth existed in the mouths of from 65% to 88% of the patients (average 80%). Abrasions existed in the mouths of from 49% to 85% of the patients examined (average of 66%). Exposure in the 20 to 29 year age group was 60% while the patients over 50 years of age showed 97%. Abrasions also increased with age both in number and severity. The results of this survey seem to justify the conclusion that the incidences of cervical exposure and abrasion are quite high and are about the same throughout the United States.

5. ORAL CONDITIONS IN A GROUP OF WORKERS EXPOSED TO ACID FUMES. *Hamilton B. G. Robinson, D.D.S., M.S., W. E. Koch, Jr., D.D.S., School of Dentistry, Washington University, St. Louis, Mo.* Ten of 18 men who had been employed from 6 to 18 months in work which necessitated daily exposure to hydrochloric acid fumes were examined clinically, radiographically and by salivary lactobacillus count. The salivary pH was measured by the colorimetric method. The age of the workers varied from 20 to 33 years. The DMF, by surfaces, on combined clinical and radiographic examination averaged 25.3, considerably lower than the figure of 39.9 reported by Hollander and Dunning for 12,753 insurance company employees of comparable age. Lactobacillus counts varied from over 50,000 to less than 100 *L. acidophilus* per cc. of saliva and only showed correlation with the carious lesions discovered radiographically and with refined carbohydrate consumption. The salivary pH range was 7.0 to 7.7 with an average of 7.34, suggesting a physiologic compensatory mechanism. From this study it is indicated that there was no relationship between the particular conditions of employment and dental caries activity. Also, there was no evidence of gingival disease, periodontal disease or alveolar bone changes related to the acid atmosphere. The erosion of anterior teeth which has been reported for similar occupational groups was not evident in these men. The need for similar surveys in other occupational groups is apparent.

6. CONGENITALLY MISSING TEETH: A PROGRESS REPORT. *Peter J. Brekhus, B.A., D.D.S., C. P. Oliver, Ph.D., and G. Montelius, M.S., D.D.S., School of Dentistry, and the Dight Institute, University of Minnesota, Minneapolis, Minn.* More than 200 individuals with congenital absence of teeth have so far been studied. Material has been collected among patients in the dental clinic, University of Minnesota, and in the kindergartens of the Minneapolis public schools. Observations: 1. Frequencies are found in the following order: (a) upper second incisors, (b) third molars in all 4 quadrants, (c) second premolars in all 4 quadrants, (d) first premolars, (e) lower first incisors. 2. Congenital absence of teeth presents a definite bilateral pattern. 3. Indication that con-

genital absence of deciduous teeth may be of prognostic value as to absence of permanent teeth. 4. Congenital absence of teeth is inherited in a large number of instances. Questions posed, 1. What is the population frequency? 2. Is there a racial difference as to frequency of congenital absence of teeth? 3. Is there a relation between the reduction of the size of jaws in modern man and congenital absence of teeth? 4. Does congenital absence of teeth indicate an evolutionary tendency to accomodate the dentition to the size of jaws and functional demands?

7. CONGENITALLY MISSING TEETH: A GENETIC STUDY. *C. P. Oliver, Ph.D., Peter J. Brekhus, B.A., D.D.S., and G. Montelius, M.S., D.D.S., The Dight Institute, and the School of Dentistry, University of Minnesota, Minneapolis, Minn.* Missing and peg-shaped upper second incisors are considered. Twenty-seven affected parents produced 31 affected among 77 offspring. Fifty-two sibships with at least 1 affected member were produced by non-affected parents; of the 186 children, 61 were affected. The condition of parents of 27 sibships was unknown. Twenty-four sibships had 2 or more affected members. Other affected relatives were recorded. Seventy-one percent of all affected persons showed bilateral symmetry; 81% had both sides involved (both missing, both pegs, or one missing and one peg). In each sibship with more than 1 affected member, all affected members were alike in 75% of the cases. Sixty-seven percent of 39 affected children resembled the affected parents; parents missing both second incisors produced affected children with both second incisors missing in 81% of the sibships. Among members of a family and in individuals, the tendency is for the anomalies to be similar and bilateral. Affected parents produced affected children in both sexes with approximately equal ratios. Genetic interpretations, missing deciduous-permanent relationships, and observations made on other teeth were discussed.

8. EFFECT OF PREGNANCY ON THE MINERAL CONTENT OF DENTIN OF HUMAN TEETH. *Martin Deakins, D.D.S., Ph.D., Harvard School of Dental Medicine, Boston, Mass.* Twenty-nine carious teeth were extracted from 20 women during the latter months of pregnancy and specific gravity determinations were made on the non-carious portions of the dentin. The average specific gravity was 2.12. By the same method the value for dentin from non-pregnant subjects was found to be 2.08. Specific gravity being a measure of the mineral content of calcified tissues, it was concluded that 1. demineralization of the sound dentin did not occur during gestation and 2. neither gestation, per se, nor demineralization of the teeth were associated with caries in this group.

VI. SECOND SESSION; AFTERNOON; MARCH 13; ABSTRACTS 9–21

9. ARE THIRD MOLAR OPERCULA FOCI OF VINCENT'S INFECTION? *D. Y. Burrill, D.D.S., M.S., and C. F. Vallotton, D.D.S., M.S.D. Northwestern University Dental School, Chicago, Ill.* In cooperation with *Commander Paul H. Wells, D.C., U.S.N.R.* Smears were taken from the mouths of 79 of 800 young men, all of the finest type. The mouths were cleaner than average. The 79 were selected because irritation and inflammation were evident in the mouth. Four

smears were taken from each mouth, 2 from lower third molar regions and 2 from about the anterior teeth, each location being currently recorded. The smears, Gram stained, were examined independently by 2 men and were graded for spirochetes, fusiform bacilli, cocci, and the higher bacteria. Spirochetes, present in all but 6 cases, were numerous in at least one region in 38 cases. Fusiform bacilli were found present in 10 cases. Infestation with spirochetes was heavier around the third molar than elsewhere in the mouth in 5 cases, and with fusiforms in 2 cases. Eight smears suggested possible Vincent's infection by the presence of both spirochetes and fusiforms in great numbers. Out of this group of 8 patients, only 1 smear for the third molar region was positive for Vincent's organisms, all others being positive in the anterior region only. Contrary to the belief that tissues around third molars serve as foci of Vincent's infection, this may possibly indicate that, in most cases another source of infection, possibly external, is to be considered.

10. GLUCOSE DEGRADATION BY STAPHYLOCOCCUS ALBUS. *Gustav Wm. Rapp, M.S., and L. S. Fosdick, Ph.D. Northwestern University Dental School, Chicago, Ill. Staphylococcus albus* isolated from human mouths contains the enzymes necessary to convert glucose to pyruvic acid according to the Meyerhof-Embden series of reactions and at widely varying rates. Lactic acid is produced but not by a simple reductive mechanism. Pyruvic acid is converted to α-keto-γ-hydroxy valeric acid and α-keto-γ-hydroxy valeraldehyde. The latter has been postulated as an intermediate in the conversion of carbohydrates to fats. Both compounds, because of their odor, may contribute to *fetor ex ore*.

11. CARBOHYDRATE DEGRADATION BY AEROBACTER AEROGENES. *Alvin F. Dodds, M.S., and L. S. Fosdick Ph.D., Northwestern University Dental School, Chicago, Ill. A. aerogenes* is quite active in the phosphorylation of glucose and in the production of phosphoglyceric acid, fairly active in the hydrolysis of phosphoglyceric acid, but only slightly active in the reduction of pyruvic acid to lactic acid. The degradation activity of *A. aerogenes* is compared with that of several other organisms previously investigated in a similar manner.

12. EFFECT OF 2-METHYL-1,4-NAPHTHOQUINONE ON CARBOHYDRATE DEGRADATION. *J. C. Calandra, Ph.D., and L. S. Fosdick, Ph.D., Northwestern University Dental School, Chicago, Ill.* Vitamin K inhibits the formation of acids from carbohydrates in the mouth. Present data indicate that the phosphorylation reaction and the conversion of hexosediphosphates are retarded in the presence of vitamin K. No effect has been noted on the conversion of phosphoglyceric acid and pyruvic acid to lactic acid.

13. ABRASION, LUSTER AND SOLUBILITY PRODUCED BY DENTIFRICES. *Wilmer Souder, Ph.D., and Irl C. Schoonover, Ph.D., National Bureau of Standards, Washington, D. C.* The report deals with the abrasiveness of dentifrices and shows a method for evaluating the loss of surface by photographing "Knoop" indentation marks after brushing the tooth surface. It shows the dangers of a misconception of the meaning of "Luster" and finally discloses the presence of soluble phosphates in one brand of dentifrice. This phosphate is known to be a decalcifying agent. Sections of teeth allowed to soak in this dentifrice said to

contain insoluble sodium metaphosphate lost weight but did not lose weight in other dentifrices. It is hoped that other research laboratories will repeat and extend this work which we cannot now follow up as we had hoped to do before we went all out on war work.

14. TOOTH CONDITION: A FACTOR IN EXPERIMENTAL ISOTOPE ABSORPTION. *Charles F. Bodecker, D.D.S., Columbia University School of Dental and Oral Surgery, New York, N. Y.* This paper was to have been presented at the cancelled 1942 New York Meeting of the A.A.A.S. and is abstracted in the *J. Am. Col. Dent.* **10:** 66, 1943.

15. ABSORPTION OF STRONTIUM ON ENAMEL, DENTIN, BONE AND HYDROXYLAPATITE AS SHOWN BY RADIO-ACTIVE ISOTOPE. *H. C. Hodge, Ph.D., Elizabeth Gavett, and Isabel Thomas, School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.* Strontium has been found to adsorb on enamel, dentin, bone and hydroxylapatite (according to the Freundlich adsorption isotherm) from solutions of strontium chloride. Radioactive strontium furnished by Massachusetts Institute of Technology was used as a tracer. Bone apparently is a better adsorber than dentin which is better than enamel. Using the data *in vivo* of Pecher, it appears that bone *in vivo* treats strontium as an entity, not as indistinguishable from calcium although the body handles strontium and calcium in analogous ways (Pecher). From the bone isotherm, it is predicted that if calcium and strontium were indistinguishable *in vivo*, much more strontium would be expected to have been adsorbed *in vivo* than Pecher found.

16. IN VIVO DISTRIBUTION OF RADIOPHOSPHORUS (P^{32}) IN VITAL AND PULPLESS TEETH OF A DOG AS INDICATED BY RADIOAUTOGRAPHS. *H. B. McCauley, D.D.S. and J. Edward Gilda, D.D.S., School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.* The teeth of diametrically opposing quadrants in a young adult dog were rendered pulpless by extirpation and the canals filled with a paste of zinc oxide and eugenol. The animal was then injected intravenously with an aqueous solution of Na_2HPO_4 containing approximately 8,000,000 counts per minute of the radioactive isotope P^{32} and sacrificed 36 hours later. The teeth were removed and sectioned in longitudinal slabs about 1 mm. thick. These were backed with lead foil and placed with the exposed side downward on no-screen x-ray film where they remained undisturbed for 46 hours. At the end of this period the sections were removed and the film developed. The resulting radioautographs reveal a striking decrease in the amount of P^{32} deposited in pulpless teeth as compared with that in vital teeth. The preponderance of the small deposit in pulpless teeth appears contiguous to the cemental covering of the root, indicating a nutritive function of the cementum and periodontal membrane. In normal teeth P^{32} appears in greatest density adjacent to the pulp, its deposit lessening with distance from circulatory elements.

17. EFFECT OF PULP EXTIRPATION ON THE METABOLISM OF PHOSPHORUS IN THE TEETH OF A DOG AS INDICATED BY RADIOACTIVE PHOSPHORUS. *J. Edward Gilda, D.D.S., H. B. McCauley, D.D.S., and E. Gunnar Johansson, D.D.S. School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.* Pulps were extirpated from the teeth of the maxillary left and mandibular right quad-

rants of a young adult dog under nembutal anesthesia, and the opened canals and chambers filled with zinc oxide and eugenol. The remaining teeth were not disturbed and served as normal controls. The dog then received intravenously 6.5 mg. of phosphorus labelled with the radioactive isotope P^{32}. On administration, the dose contained 8 million counts per minute of P^{32} as measured on a scale-of-four Geiger Muller counter, an amount roughly equivalent to 0.1 millicurie. Thirty-six hours after injection, the animal was sacrificed and the teeth removed and prepared for radiophosphorus determinations. A small but definite metabolism of phosphorus in pulpless teeth was demonstrated. About 4 times more P^{32} was deposited per gram of whole tooth substance in normal teeth than in pulpless teeth. Pulp extirpation apparently affected the crown much more than the root in that the crowns of normal teeth took up on the average approximately 8 times the amount of P^{32} detected in the crowns of pulpless teeth, whereas the average vital to pulpless ratio of P^{32} in the roots was 3.5. The P^{32} found in the crowns was consistently of smaller magnitude than that detected in the roots but this tendency was greatly exaggerated in the case of pulpless teeth.

18. OBSERVATIONS ON THE ADSORPTION OF FLUORIDE BY THE ENAMEL. *J. F. Volker, D.D.S., Ph.D., Tufts College Dental School, Boston, Mass.* Previous experiments have indicated that when powdered enamel is exposed to various aqueous solutions of NaF, for periods of 1 hour, the acid solubility of the enamel is reduced. This has been interpreted to indicate that the enamel surface has adsorbed fluoride. In a continuation of these experiments samples of enamel have been exposed to solutions of CaF_2 and NaF containing approximately 8-PPM of fluoride for periods as little as 5 minutes. When the acid solubility of the experimental enamel samples were compared with an untreated control it was observed that both the NaF and CaF_2 treated enamel showed a comparable and significant reduction. These findings indicate that in general the adsorption of fluoride by enamel is not effected by the nature of the soluble fluoride salt and that the reaction takes place within a very limited time.

19. EFFECT OF MANGANESE AND BORON COMPOUNDS ON THE RAT INCISOR. *George D. Wessinger, Ph.D., and J. P. Weinmann, M.D., Foundation for Dental Research of the Chicago College of Dental Surgery, Chicago, Ill.* Manganese chloride adminstered subcutaneously to white rats in dosages greater than 180 mg./kg. produces enamel hypoplasia. The lethal dose of this compound for white rats is approximately 800 mg./kg. The subcutaneous administration of borax and/or boric acid with a total boron content of less than 200 mg./kg. does not cause enamel hypoplasia. Larger doses than this were not tried in this experiment. The injection of manganese chloride interrupts amelogenesis in the apical one-fourth of the zone of matrix formation. This is in contrast to hypoplasias produced by strontium which extends over the whole formative zone (cf., abstract 43). Various agents may affect ameloblasts in different stages of their life cycle.

20. DIMENSIONAL ATTRIBUTES OF DECIDUOUS DENTIN (PRELIMINARY REPORT). *M. P. Doyle, B.S., D.D.S., and S. S. Arnim, B.A., D.D.S., Ph.D., Medical College of Virginia, School of Dentistry, Richmond, Va.* This presentation is a prelimi-

nary report concerning the thickness of dentin in the coronal part of deciduous teeth. The technic employed in making the measurements will be described. Data collected through study of the deciduous mandibular second molar will be summarized.

21. The abraisiveness of dentifrices. *M. L. Tainter, M.D., and Sidney Epstein, D.D.S., College of Physicians and Surgeons, A School of Dentistry, San Francisco, Cal.* A machine for testing the abrasiveness of dentifrices and their ingredients on human teeth has been developed and used, and the conditions for reliable use established. There is a linear relationship between the mean size of particles and the amount of abrasion of enamel for powders of calcium carbonate and dicalcium phosphate. Commercial dentifrices now being sold range in abrasiveness from values between one-half and twice the abrasiveness of precipitated calcium carbonate for pastes and powders, and from one-sixth to one-half as abrasive for the liquid dentifrices. The glass-slide procedure is useful primarily for detecting traces of highly abrasive materials which might scratch the teeth. The actual abrasive power can be estimated approximately by this method, but not with sufficient accuracy to be usefully applied to an individual product. No correlation could be demonstrated between the amount of abrasion of human enamel and that on plates of either antimony, silver or copper, so that these metals are not satisfactory test objects for abrasive power of materials to be used as dentifrices.

VII. Third Session: (Materials Section) Evening, March 13; Abstracts 22–27

22. Clinical observation on amalgams with known physical properties. *R. W. Phillips, B.S., D. A. Boyd, D.D.S., H. J. Healy, D.D.S., W. H. Crawford, D.D.S., School of Dentistry, University of Indiana, Indianapolis, Ind.* The purpose of this investigation is to observe the clinical behavior of amalgam fillings which have been placed by varying controlled technics. The operators perfected themselves in a technic which produced expansion of 25 microns when alloy was under amalgamated, 9 microns by using manufacturer's directions, and contraction of 4 microns in the 3 minute mix. One hundred and thirty fillings, using all the 3 mixes, were placed in the mouth and have been examined after 6 month period. Observations show apparent expansion of restorations which were underamalgamated and contraction on the 3 minute mix. No apparent clinical difference was observed between manufacturer's directions and 3 minute mix. Under amalgamated restorations were inferior in terms of tarnish and roughness. Amalgam tested for delayed expansion caused by contamination. Only 2 restorations were contaminated and both gave evidence of excessive expansion. (Published in *J. D. Res.* **22:** 167, 1943, this issue).

23. Effects of solvents and plasticizers on poly methyl methacrylate. *H. M. Vernon, Pittsburgh, Pa.* To show effects of solvents on plasticized and unplasticized methyl methacrylate polymer a number of molding powders on the market were examined as to the absorption of an aqueous solution of 70% ethyl alcohol which is not a solvent for pure methyl methacrylate, but attacks the resin when strained. Compression molded specimens were drilled to induce

strains and the solution sealed in the drill holes. Rate of penetration of reagent was observed by visual and microscopic comparison and the results photographed. Similar tests were made of monomer-polymer mixtures and comparisons made on some powders containing pure monomer and monomer containing plasticizers. Observations were also made of cracking temperatures of polymerized monomer-polymer mixtures.

From these tests it was concluded that polymerized methyl methacrylate resins containing plasticizer showed greater penetration of the alcohol solution than unplasticized resins. The minimum cracking temperature of plasticized resins was lower than those of unplasticized materials. The presence of plasticizers, represented by n-butyl phthalate, have a marked inhibiting action upon the rate of polymerization. Rate of penetration of monomer and other solvents is also accelerated by the presence of plasticizers. In commercial practice it has been observed that the higher plasticized polymers are subject to considerable elastic recovery after molding with change of size or tendency to unmold. It is suggested that this effect is one of the main factors of post molding change in restorations using methyl methacrylate.

24. DIMENSIONAL STABILITY OF DENTURE RESINS. *E. N. Cooper, B.S., and E. W. Skinner, Ph.D., Northwestern University Dental School, Chicago, Ill.* Irregularly shaped specimens constructed from 4 commercial denture base resins were studied as to dimensional stability while immersed in water at 37°C. for 7 weeks, 12 weeks and 20 weeks respectively. Although none of the specimens fit the brass models on which they were processed, the measurements or "indices" of the discrepancies over selected areas appeared to be symmetrical, probably because of an inward movement of the outer portions. The discrepancies were less after 7 weeks' storage than immediately after processing, but became greater at the 12-week storage, and then less at 20 weeks. Very little change was observed after storage in water at 75°C. for 1 hour, but a marked increase occurred after a similar treatment at 85°C. These changes were generally not influenced by the method of processing. A processing at 100°C. for 8 and 13 hours respectively resulted in much lower discrepancies for the 13-hour specimens when subjected to foregoing treatments, with no marked change even when treated at 85°C. A similar degree of dimensional stability resulted with specimens cooled in dry ice after a normal processing time and temperature.

25. TINFOIL SUBSTITUTES FOR PROCESSING ACRYLIC DENTURES AND THEIR EFFECT ON THE FINISHED PRODUCT. *Eugene J. Molnar, M.D., D.D.S. and Thomas E. Moore, M.S., Toledo, Ohio.* The authors give some theoretical explanation of the adherence of the denture material to the confined matrix during the processing. The most important requirements of a good separating medium are: 1. It should be water repellent and insoluble in water. 2. It should be insoluble in the resin liquid, and incompatible with it. 3. It should produce a suitable film which separates the denture from the confining matrix. 4. It should not influence the physical and chemical properties of the final product.

Tinfoil has a number of disadvantages. Among the numerous film-making materials used as substitutes for tinfoil with varying degrees of success, are—

the film-making polysaccharides, particularly the different starches and their esters, and the cellulose acetate butyrate. The cloudiness of the resin is caused by water in the form of an emulsion. It occurs with the use of substitutes and is more visible in copolymer resins. The cloudiness may be dispelled by a second curing under tinfoil and with the application of some pressure produced by adding more resin. The physical and chemical properties of the cured resin do not appreciably change with the use of tinfoil substitutes. The final products meet the specifications of the A.D.A. The initial surface hardness is slightly lower if a substitute is used but the hardness remains constant or tends to increase when stored in water at 37°C. The tinfoiled specimens, however, tend to decrease in surface hardness under these conditions. Using substitutes, the curing linear shrinkage is less than for tinfoiled specimens.

26. Co-polymers of methyl-methacrylate. *Fred A. Slack, Jr., D.D.S., Philadelphia, Pa.* It is presented that methyl-methacrylate has working qualities that are particularly advantageous to the dental profession. These characteristics indicate that its continued use in this field is probable. It is advanced that some of these properties may be improved by the addition of small amount of other plastics to form co-polymers, inter-polymers, or blends. An effort is made to change certain characteristics of methyl-methacrylate by co-polymerization. The additions include styrene, vinyl-resin and maleic-anhydride-acrylic in various proportions. It is emphasized that although certain results indicate encouragement, further work is necessary to present definite conclusions.

27. Flow of methyl methacrylates: a progress report. *A. B. Gabel, D.D.S., M.A., and E. Howell Smith, D.D.S., University of Pennsylvania, Philadelphia, Pa.* Forces approximating 3550 pounds per square inch applied intermittently 100 times, produced only an extremely small shortening of cylindrical specimens which returned to their original length in a few minutes. Smaller strains as shown by the photoelastic effect, were dissipated immediately upon removal of the applied force. Specimens loaded to 7200 pounds per square inch for 5 minutes recovered completely within 5 minutes after several loadings. A coefficient of restitution against glass was obtained for steel, acrylic, gold and amalgam spheres. Next to steel, acrylic had the highest coefficient. Some specimens loaded for hours and even days, were found to reach a point beyond which there was no further distortion. Even these specimens showed a tendency to recover partially their original dimensions. A study of the equations of some of the curves obtained verified the above findings by showing a decrement of the rate of flow, which is definitely logarithmic. This applies to both compression and recovery. The findings to date seem to indicate that methyl methacrylate tends to behave like a true elastic but has a definite time lag in its reaction to loading and a hysteresis effect. (To be published in *J. D. Res.*)

VIII. Fourth Session: Morning, March 14; Abstracts 28–38

28. A structureless pellicle of the enamel surface. *Charles F. Vallotton, University of Rochester, School of Medicine and Dentistry, Rochester, N. Y.* A pellicle was found on the lingual and labial surfaces of the teeth, particularly

the anterior, in a large percentage of individuals who used no abrasive in their daily mouth care. Toothbrushing with or without a liquid dentifrice did not prevent the formation of the pellicle nor remove it when formed. A few days to 2 weeks were necessary for the pellicle to collect. A brown pigmentation appeared simultaneously. The pellicle could be differentiated from any known enamel surface structure such as the enamel cuticle, mucin plaque, materia alba, bacterial film, brown stain or calculus. Scrapings examined microscopically revealed a thin homogeneous, somewhat translucent, structureless material. Its general staining reaction was acidophilic. Some similarity to keratine in staining properties, particularly when using Mallory's aniline blue, was observed. Staining for mucin gave atypical and doubtful results. Fats, amyloide, and hyaline substances were not detected. The possibility that the pellicle was a bacterial film was ruled out by staining for bacteria. The material was analyzed spectrographically and carbon, hydrogen, nitrogen and ash microdetermined.

29. THE MICROBIC FLORA OF SALIVA AND DENTAL PLAQUES. *Elizabeth S. Hemmens, J. R. Blayney and R. W. Harrison, Walter G. Zoller Memorial Dental Clinic and the Department of Bacteriology, University of Chicago, Chicago, Ill.* Cultures of saliva and plaques taken simultaneously from 60 patients with active caries were made on acid (pH 5.0) and neutral media and compared as to relative incidence of cultivable forms. No qualitative differences were found in the floras of the 2 sources but some quantitative differences were noted. Diphtheroids, gamma streptococci, anaerobic gram negative cocci, one type of fusiform bacillus and filamentous forms were more common in plaque cultures than in the saliva and the reverse was true of yeasts, micrococci and, to a slight degree, of lactobacilli. Some other bacteria, including several species of Neisseria, and alpha and beta hemolytic streptococci, some gram positive rods, and other fusiform bacilli showed no appreciable differences in incidence in cultures from the two sources.

30. COMPARATIVE STUDIES ON ORAL AND INTESTINAL LACTOBACILLI. *Zdenka Z. Opal and R. W. Harrison, W. G. Zoller Memorial Dental Clinics, University of Chicago, Chicago, Ill.* At intervals of 1 or 2 weeks extending over a period of 6 weeks, samples of saliva and stool specimens were collected from 11 children and cultured for lactobacilli. Cultures were made on Kulp's acid tomato agar and incubated aerobically at 37°C. Of 44 paired specimens collected, 41 saliva samples and 32 stool specimens yielded lactobacilli. Each morphologically distinguishable variety of lactobacillus found in each specimen was subcultured for further examination. Fifty-eight oral and 40 intestinal were studied morphologically, biochemically and immunologically, shortly after isolation and again after a few months of cultivation in laboratory media. Each morphological type found was represented in both groups. There were somewhat fewer intestinal strains (15%) than oral strains (36%) in the smooth, Group I of Hadley, Bunting and Delves. The morphological characteristics of many strains, however, were unstable and after a few subcultures the distribution of morphological types within the two groups was almost identical.

Fermentation reactions were determined in glucose, levulose, galactose,

lactose, maltose, sucrose, xylose, arabinose, raffinose, sorbitol, mannitol, inulin, dextrin and litmus milk. At the time of isolation most of the cultures fell into the same fermentation groups and after changes which occurred within a few weeks the proportionate distribution was the same for the oral and intestinal strains. The results with immunological tests were similar. No immunological type was found in either group that was not represented in the other and the number of strains in any one type was proportionately equal in the 2 groups.

31. IN VITRO STUDIES ON STERILIZATION OF CARIOUS DENTIN. *John A. Muntz, Albert Dorfman and Robert M. Stephan, Walter G. Zoller Memorial Dental Clinic, University of Chicago, Chicago, Ill.* The restoration of extensive carious lesions frequently requires exposing the pulp if all the carious dentin is to be removed. If carious dentin could be effectively sterilized, it might be possible to leave a small amount of it in such cavities as a base for the filling material and thus avoid making a pulp exposure.

A method was devised for determining the ability of germicides to sterilize pieces of carious dentin of known size. Of a large number of commonly used germicides tested, only saturated silver nitrate and 30% hydrogen peroxide (superoxol) were able to sterilize pieces of carious dentin under the conditions employed. Since silver nitrate was by far the most efficient compound studied, a further quantitative study was made of its ability to penetrate and sterilize carious dentin. It was found that saturated silver nitrate applied for 3 minutes penetrates to slightly more than 1 mm. but sufficient concentrations for sterilization were uniformly achieved only to a depth of 0.25 mm. In some cases the samples were sterilized to a depth of 0.5 mm.

32. STUDIES ON THE EXTENT OF INFECTION AND STERILIZATION OF CARIOUS DENTIN. *Robert M. Stephan, John A. Muntz, and Albert Dorfman, Walter G. Zoller Memorial Dental Clinic, University of Chicago, Chicago, Ill.* Considerable controversy has existed concerning the extent of infection in carious lesions, and the efficacy of applying germicides in sterilizing any infected dentin left in a cavity before filling. These studies were designed to answer these questions.

The presence of microorganisms was determined by culturing samples taken at various levels in unprepared carious lesions of freshly extracted teeth. Two methods of sampling were used: (a) starting on the carious surface and going to sound dentin, and (b) starting in sound dentin and going into carious dentin. In a large number of teeth, the superficial layers of carious dentin were always infected, the intermediate layers were sometimes infected, and the partially decalcified dentin adjacent to the sound dentin and the sound dentin were uniformly sterile.

A special apparatus was constructed which permitted the determination of the depth of sterilization produced by germicides in carious lesions of extracted teeth. It was found that a saturated solution of silver nitrate sterilized infected carious dentin to an average depth of 0.33 mm. by a 1 minute application, 0.73 mm. by a 3 minute application, and 1.25 mm. by a 10 minute application. A 30% solution of hydrogen peroxide (superoxol) was less effective, and a 20% solution of Zephiran was ineffective.

33. THE EFFECT OF SODIUM FLUORIDE APPLICATIONS ON DENTAL CARIES. *B. G. Bibby, B.D.S., Ph.D., Tufts College Dental School, Boston, Mass.* At intervals of approximately 4 months during a period of 2 years applications of 1/1000 of sodium fluoride were made on the teeth in one quadrant of the mouths of a group of children. The other side of the same jaw was used as a control. The increase of caries in the treated quadrant was compared with that in the untreated quadrant. Of an initial group of 100 children, 90 were examined at the end of the first year, and 78 at the end of the second year. Examinations were made with a mirror and explorer and were carried out without knowledge of which were the treated and which were the control quadrants. Results are presented below:

TEST PERIOD	NUMBER OF CHILDREN	TEST QUADRANTS			CONTROL QUADRANTS		
		New caries	Questionable change	Total caries	New caries	Questionable change	Total caries
1st year	90	32	69	101	59	82	141
2nd year	78	53	30	83	72	48	120
1st and 2nd years	78	82	87	169	123	111	234

In the 78 children completing the 2 year test period a total of 438 teeth were treated with the fluoride and 434 were used as controls. At the beginning of the test there were 196 carious tooth surfaces in the test and 195 in the control teeth. Caries was reduced in the incisors and canines by 32% and the premolars by 34% and in the molars by 40%. Although the extent of caries reduction during the second year was not as large as during the first, there was a distinct reduction in caries activity in the treated quadrants.

34. EFFECT OF INGESTED IODOACETIC ACID ON EXPERIMENTAL DENTAL CARIES IN THE RAT. *Peter P. Dale, D.M.D. and Vernon H. Powell, D.D.S., School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.* To determine whether the inhibition of experimental caries in rats by iodoacetic (iodoethanoic) acid is a function of its presence in the food, the drinking water, or both, 52 young female albino rats of an inbred stock were maintained for 150 days on the caries-producing Hoppert-Webber-Canniff coarse corn diet. All animals were allowed unrestricted rations. Iodoacetic acid ingested in the amounts given did not alter normal growth. Caries scores obtained at the close of the experimental period averaged 184 for a group of control animals, 11 for a group which received a supplement of 200 p.p.m. of iodoacetic acid in the food alone, 64 for a group which obtained 20 p.p.m. of iodoacetic acid in the water alone and 5 for a group which obtained both supplements. Apparently iodoacetic acid in the drinking water is capable of causing a reduction in carious lesions in the rat although results obtained in earlier reports are explained by its presence in the food alone. Within the limits of the experiment the relative effectiveness of iodoacetic acid in inhibiting dental caries appears to be correlated with the amount ingested rather than with the mode of ingestion. (Published in *J. D. Res.* **22**: 33, 1943).

35. FLUORINE THERAPY IN DENTIN DESENSITIZATION. *B. G. Bibby, B.D.S., Ph.D., and W. H. Hoyt, D.D.S., Tufts College Dental School, Boston, Mass.* Experiments have been carried out to test the effectiveness of sodium fluoride in obtunding sensitive dentin. On the basis of a large number of treatments, which include those given to a well-controlled group of 70 private patients, it has been shown that sodium fluoride is an extremely effective agent in desensitizing dentin. The effects of treatment last for many months, varying with the individual patient. It is suggested that pending further study, this reagent should be used with caution.

36. FURTHER OBSERVATIONS OF DENTAL LYMPH IN THE DENTIN. *William Lefkowitz, School of Dental and Oral Surgery, Columbia University, New York, N. Y.* This paper appeared on the program of the cancelled 1942 New York meeting of the A.A.A.S. and the abstract is published in the *J. Am. Col. Dent.* **10:** 67, 1943.

37. THE MASTICATORY APPARATUS IN SLOTHS. *Harry Sicher, The Foundation for Dental Research, Chicago College of Dental Surgery, Chicago, Ill.* Bradypus and Choloepus have a descending process of the zygomatic bone. The zygomatic arch is incomplete. The fibers of the masseter muscle are partly horizontal, running from the descending part of the zygoma to the upper part of the mandibular ramus. The masseter exerts, together with the external pterygoid, a strong anterior pull. This is active in Choloepus to assure a sharp contact between the caniniform first teeth which at rest do not articulate. In Bradypus the knoblike condyle of the mandible occupies in rest position the anterior part of the articular fossa. In opening the mandible is pulled backwards. The masticatory stroke is directed forward and is the function of the horizontal part of masseter and external ptergoid. The fusion of sternohyoid muscle and anterior belly of digastric muscle—complete in Choloepus (sternomandibular muscle), incomplete in Bradypus—forms the antagonist to the horizontal part of the masseter.

38. EFFECT OF CAVITY AND PATTERN DESIGN ON STRUCTURES, STRESSES, STRAINS, AND DENSITY OF CASTINGS. *Donald A. Keys, A.B., D.D.S., and B. L. Hooper, D.D.S., College of Dentistry, University of Nebraska, Lincoln, Nebr.* In the technic used to produce restorations with the gold inlay, a factor concerning the control of the physical state of the completed casting has received little attention. Careful examination reveals deficiencies in the structure of the casting, some of which it is possible to remedy by observing certain principles in cavity shape and design. An important feature in the crystalline structure of castings is that which is met where sharp angles occur. Crystals meeting at right angles tend to produce a porous condition from the angle to the opposite casting surface. If there is a cove formation or reduction of the abrupt boundary area at the angle vertex, these crystals tend to assume a gradual radial inward direction and produce a casting of greater density along the usual lines of weakness. Modified cavity preparation which eliminates sharp angles by the use of the cove cutting bur designed by B. L. Hooper produces the desirable curvature where all cavity surfaces meet. The plan permits better adaptation of the wax pattern, less chance for distortion of the wax, and finally a better fitting and more dense

restoration. Further work is being done to study the effect of cavity design as it influences other restorative materials.

IX. Fifth Session: Afternoon, March 14; Abstracts 39–50

39. Evidence of assyro-babylonian dentistry. *George B. Denton, Ph.D., Northwestern University Dental School, Chicago, Ill.* Letter K.1102, H.586, of the royal Assyrian correspondence, has been regarded as important in revealing the development of dentistry as early as the seventh century B.C. The letter has been generally interpreted as giving a diagnosis of systemic infection due to the teeth and as prescribing extraction of the teeth as the treatment. The modernity of the diagnosis has puzzled some historians, but the prescription that the teeth be extracted has never been questioned. Yet, this prescription, if correctly translated, is the earliest known mention of the operation and antedates any other mention by several centuries. Moreover, the skeletal remains from early Egypt suggest that even badly diseased teeth of royalty were not extracted, but were left loose and ready to fall out of the jaws. In view of these facts, the translation has been re-examined. A footnote to McKnight's translation (1906) indicated that the letter actually says, "The teeth are to come forth," which McKnight thinks—and in this he has been followed by all other translators—can only mean, "must be extracted." It is more likely, however, that the Assyrian physician meant only what he said, "The teeth are to come out," indicating their condition, not their treatment. With the possibility of this interpretation in view, the historian can scarcely make any positive statement about the advanced state of dentistry in that early period.

40. Enamel hypoplasia as interpreted on the basis of recent studies in enamel development. *F. Wassermann, M.D., Walter G. Zoller Memorial Dental Clinic and the Department of Anatomy, University of Chicago, Chicago, Ill.* Disturbances in enamel development resulting in so called hypoplasia may occur in either the period of production or of maturation of the enamel matrix. Therefore, it is necessary to distinguish between hypoplasia due to deficient formation and that due to incomplete maturation of the matrix. Formation can be deficient by retardation or suppression of the secretory activity of the ameloblasts or by a deficient formation of the enamel ground substance. Finally both processes can be inhibited with the result of total defects in the enamel. Hypoplasia on the basis of deficient maturation may be due to a disturbance of either one of the main processes upon which maturation depends: the uptake of calcium, or the removal of organic material and of water. The result is the same in both cases as calcification and removal of organic substances are interdependent. The irreparability of the maturation-hypoplasia is a further evidence that the removal of organic material during maturation is a function of the ameloblasts. It cannot be made up once the ameloblasts are gone. Additional calcium uptake which remains possible throughout life cannot repair the hypoplasia without simultaneous removal of the organic substance.

41. Amelogenesis. *B. Orban, M.D., D.D.S., H. Sicher, M.D. and J. P. Weinmann, M.D. The Foundation for Dental Research of the Chicago College*

of Dental Surgery, Chicago, Ill. Enamel matrix formation was studied mainly on decalcified sections of rat incisor. Amelogenesis starts with development of the dentino-enamel cuticle—a fusion of the basement membrane of the dental papilla and a cuticular product of ameloblasts. After development of the cuticle the ameloblasts produce hexagonal, prismatic Tomes' processes. The boundary between cell bodies and Tomes' processes is marked by prominent terminal bars. The dentinal ends of Tomes' processes are transformed into enamel rods whereas their cellular ends are continuously and simultaneously rebuilt by a secretory activity of the ameloblasts. The first stage in the transformation of Tomes' processes into rods is a homogenization of their dentinal ends. The homogenized material is immediately changed into pre-enamel matrix. This transformation occurs rhythmically and excentrically at the apical side of each rod. The rhythmical transformation leads to segmentation of the rod, which will persist as cross striations of mature enamel rods. Homogenized Tomes' processes are argyrophil, preenamel is argyrophobic. Preenamel matrix consists only of organic material; it is basophil and acid resistant. When preenamel matrix is about 20 microns thick it starts to calcify. Young enamel matrix is slightly acidophil. The change into the fully developed matrix is characterized by further influx of calcium salts. At the same time the staining reaction again changes into basophil. The interrod substance is continous with projections of terminal bars between Tomes' processes. The rods always form an angle with the ameloblasts and Tomes' processes. Each rod is the product of one ameloblast.

42. FURTHER OBSERVATIONS CONCERNED WITH AMELOGENESIS AND CALCIFICATION IN THE FIRST MOLAR OF THE RAT. *James Nuckolls, D.D.S., J. B. deC. Saunders, M.B., Ch.B., F.R.C.S. (Ed), and Harry E. Frisbie, D.D.S., University of California, College of Dentistry, San Francisco, Cal.* Subsequent to an earlier publication on amelogenesis further studies have been made, which, with certain modifications lead to the clarification of our original concepts. In this study we have been able to trace the pre-enamel processes in an unbroken continuity from their apices to the dentin-enamel junction even when a considerable amount of matrix has been formed. In the fully developed stage the processes assume their characteristic form as delicate parallel processes extending peripherally on either side of the rod to merge by their apices with the cell membrane of the ameloblast. Interpretation of the appearance of the terminal bars: 1. They are not pronounced in undecalcified material which has never been subjected to staining methods involving the use of acids. 2. They appear to a moderate degree as a linear line when undecalcified material has been subjected to stanining methods involving the use of acids. 3. They appear to a marked degree as heavy dots when the material has been subjected to acid decalcification. From the results of our work we regard enamel development as occuring in 3 phases: 1. Matrix formation and hyalanization of the rod, 2. Primary calcification following matrix formation, 3. Secondary calcification or maturation occuring prior to eruption.

43. RECOVERY OF AMELOBLASTS. *J. P. Weinmann, M.D., The Foundation for*

Dental Research of the Chicago College of Dental Surgery, Chicago, Ill. The effects of strontium chloride on the rat incisor was studied in 38 animals 6 to 13 weeks old. The animals were given single subcutaneous injections of strontium chloride solution in dosages varying from 700 to 4000 mgm. per kilogram body weight. Strontium chloride solution in dosage of and over 700 mgm. per kgm. causes severe changes in dentin, and hypoplastic defects of enamel. In the present study only changes in enamel and enamel organ are considered. The changes are localized to the entire area on the rat incisor where formation of enamel is in progress at the time of injection. The chronologic sequence of changes are: ablatio of the enamel organ, disorganization of the ameloblastic layer and slight morphologic changes of the stratum intermedium and outer enamel epithelium. On the second day reparative changes set in. The ablatio disappears first by reattachment of the enamel organ to the hypoplastic enamel matrix. Later the disorganized and degenerated ameloblasts reorganize and redifferentiate to a certain degree. The recovered ameloblasts to not resume enamel matrix production and the hypoplastic enamel matrix does not undergo maturation.

44. TOOTH DISTURBANCES IN A CASE OF CHRONIC HYPOCALCEMIA. *Smith Freeman, Ph.D., M.D. and Wm. G. Skillen, D.D.S., Northwestern University Dental School, Chicago, Ill.* A female patient, age 36, stated that she had, for the past 10 years, general convulsive seizures as well as recurrent, cramp-like pains of fore-arms, hands and legs, and dizziness. Etiology was unknown. Physical examination was essentially negative. All incisor teeth demonstrate very early occurrence of enamel hypoplasia and prevelant caries. Dentin exhibits somewhat exaggerated pre-dentin with slight tendency to inclusion of pulp tissue. Two teeth, a molar and a premolar, exhibit relatively large internal resorption with attempted repair by bone-like tissue.

45. AVERAGE WEIGHTS OF THE PERMANENT TEETH, INCLUDING THE RELATIVE AMOUNTS OF ENAMEL TO DENTIN AND CEMENTUM. *Virgil D. Cheyne, D.D.S., Ph.D., and John T. Oba, B.S., Indiana University School of Dentistry, Indianapolis, Ind.* From approximately 500,000 teeth extracted by Indiana dentists, 759 sound specimens, representing the 32 permanent types, were selected. Only those were used which conformed to normal anatomic form and exhibited a minimum amount of wear. In all cases the roots were completely formed; those with excessive amounts of secondary cementum were not used. The teeth were carefully cleaned and placed in a humidifier until the moisture content attained an equilibrium. Enamel was separated from dentin and cementum by the Manly-Hodge flotation method. The average weight of each tooth type and the per cent of enamel (expressed in parenthesis) was as follows: maxillary teeth; 1st I. 1.1917 (22.02%), 2nd I. 0.8171 (21.30%), can. 1.2821 (22.01%), 1st Pr. 1.2283 (22.67%), 2nd Pr. 1.1266 (19.43%), 1st M. 2.4830 (23.79%), 2nd M. 2.1780 (20.48%), 3rd M. 1.7323 (23.30%); Mandibular teeth; 1st I. 0.5494 (12.67%), 2nd I. 0.6326 (18.83%), can. 1.0945 (12.44%), 1st Pr. 0.9712 (16.96%), 2nd Pr. 1.0934 (29.58%), 1st M. 2.3175 (21.87%), 2nd M. 2.2656 (26.10%), 3rd M. 1.9891 (26.15%). Summary figures disclose 22.9524 grams

of tooth substance in the average adult dentition; the average ratio of enamel to dentin and cementum is 3.51. (Published in *J. D. Res.*, **22**: 181, 1943, this issue.)

46. Loss of teeth in the adult white population. *Henry Klein, D.D.S., Sc.D., U. S. Public Health Service, Bethesda, Md.* Analysis of material on approximately 38,000 persons representing white adults of the United States reveals that on the average a white person loses 1 permanent tooth every 2½ years over the adult age range from 17 to beyond 65 years. Socio-economic status has a positive influence in reducing the rate at which the permanent teeth are lost. Persons whose family incomes are $3,000 or more per year lose their permanent teeth at a lower rate than other persons whose family incomes fall under $2,000 per year. The data are presented on a tooth life table basis, and it is shown that persons whose family incomes are $3,000 or more per year are able to obtain approximately 130 more *tooth years* of service from their permanent teeth than persons whose family incomes are under $2,000 per year. (Published in J. A. D. A., **30**: 80, 1943.)

47. Systemic influence upon bone changes in periodontoclasia. *Irving Glickman, B.S., D.M.D., Anna Morse, M.S., and Leonard Robinson, A.B., Tufts College Dental School, Boston, Mass.* A controlled experiment was conducted in order to determine whether altering the systemic background of albino rats would affect the nature of the changes seen in the bone subjacent to inflammation in the region of the gingival crevice. Gingival inflammation was induced in all cases by packing amalgam in the interproximal space between the first and second mandibular molars or by traumatizing the gingival tissues with a probe. The systemic background was varied experimentally. In the control animals in which the experimental background was not altered, the margin of the interdental bone subjacent to the inflammation showed both resorption and deposition, the former predominating. The remainder of the interdental bone was essentially unaltered. Animals which were starved showed only resorption along the bone margin subjacent to the inflammation and in addition presented necrosis and sequestration of the underlying bony septum. Marked resorption also predominated at the gingival margin of the interdental septa in the starvation animals in areas where there was no gingival inflammation. Bone deposition seen throughout the jaws in the control group was strikingly reduced in the starvation animals where generalized osteoporosis of the jaws was observed.

48. Preliminary report on the absorption of procaine by tissue. *V. R. Ohlen, D.D.S., A. D. Hirshfelder, M.D.* and W. J. Simon, D.D.S., M.S.D., School of Dentistry, University of Minnesota, Minneapolis, Minn.* In this report the method of determining the absorption of procaine by tissue is colorimetric. The technique is a modification of the Bratton and Marshall colorimetric test for the concentration of sulfanilamide in blood. Blood samples from 2 full grown rabbits revealed no colorimetric reaction before experimentation. Into these rabbits 2 cc. of 2% procaine hydrochloride with 1:32000 epinephrine were

*Deceased October 11, 1942.

infiltrated. At intervals 2 cc. samples of blood were withdrawn from the heart of each rabbit. All blood samples were laked in 3 cc. of water immediately. The technical procedure applied to the samples is described in the University of Minnesota laboratory manual of pharmacology for medical students. These blood samples were compared to the standard in a colorimeter. Into 3 male subjects 5 cc. of 2% procaine hydrochloride with 1:32000 epinephrine were infiltrated. In these cases a lower third molar was extracted. At 15 minute intervals .2 cc. blood samples were withdrawn from the socket. These samples were treated in the manner described. The results for both the animal and clinical experiments were computed in mg./cc. of blood. 1. By means of the sulfanilamide test it is possible to determine quantitatively the amount of procaine coursing through the heart of an animal which has been injected at another site. 2. The absorption of 2% procaine hydrochloride with epinephrine 1:32000 by tissue depends upon intrinsic factors inherent to the tissue and extrinsic factors such as: the amount and concentration injected, the site of injection, the point of recovery, and the gross weight and quantity of the absorbing tissue. 3. Paradoxically, this investigation reveals that in the process of absorption there is a secondary surge in the systemic circulation; whether or not this is due to the release from epinephrine is a matter for further investigation.

49. BONE CHANGES IN EXPERIMENTAL CHRONIC FLUORINE INTOXICATION. *William H. Bauer, M.D., D.D.S., St. Louis University Dental School, St. Louis, Mo.*
Studies were made on 16 dogs of various ages to learn (1) how chronic fluorine intoxication affects bones of adult dogs, (2) how it affects bones of puppies, and (3) if vitamin D prevents or alters bone changes in puppies. Chronic fluorine intoxication produced systemic bone disease. (1) Long bones of adult dogs revealed, radiographically and microscopically, changes identical with those described in man by Roholm and J. Bauer, Bishop, and Wolff. Radiographically, long and flat bones showed thickening, intercostal tissue was calcified and striking density of cortex extended here and there throughout long bones, encroaching upon or obliterating medulla. Microscopically, there was irregular and coarse calcification of dense periosteal and endosteal bone formation. Bone trabeculae contained large, irregularily arranged osteocytes, were adequately calcified and coated with osteoid zones of normal width but with many lines of resorption and apposition. Bone marrow was fibrous and granular masses of calcium were in interosseous tissue. (2) Radiographically, long and flat bones of young dogs and puppies fed on fluorine diet for 29 to 128 days revealed marked osteoporosis extending into compact bone. Extremely wide, poorly calcified periosteal bone formation, especially about tendon insertions, compensated for osteoporosis. Original outlines of bones were fairly well preserved although covered by huge masses of new periosteal bone. Microscopically, dense layers of osteoblasts and thick osteoid zones outlined irregularly calcified trabeculae while spongy bone was resorbed. Ossification lines were irregular in ribs. Three animals had deeply stained granules of various sizes in osteoblasts, osteocytes, and osteoclasts as well as matrix, particularly in and around older bone. Bone

marrow in affected areas was hyperemic and fibrous; some sections showed perivascular small cell infiltration. (3) Vitamin D had no influence on the bone changes. The bones of 2 puppies suckled by mother with chronic fluorine intoxication showed lively periosteal bone formation before tooth-bud changes became perceptible.

50. BACTERIOSTATIC EFFECTS OF QUINONES. *W. D. Armstrong, Ph.D., M.D., and J. W. Knutson, D.D.S., Dr. P.H., Laboratory of Dental Research, University of Minnesota, Minneapolis, Minn.* The relative efficiency of a number of quinones in preventing acid formation in saliva-glucose mixtures incubated with shaking for 4 hours has been determined to lie in the following descending order: 1,4-napthoquinone; 2-methyl-1,4-napthoquinone; 1,2-napthoquinone 2,6-dimethoxybenzoquinone; p-benzoquinone; toluquinone; quinhydrone; 1,2-napthoquinone-4, potassium sulfonate; hydroquinone; 2-hydroxy-1,4 naphthoquinone; toluhydroquinone; sodium-beta-napthoquinone-4-sulfonate; sodium anthra-quinone-beta-sulfonate and sodium-2-methyl-1,4 napthohydroquinone disulfate. The first 7 compounds prevent the pH from falling below 5 when in concentrations greater than 2 mg. per cent. The substances exert a bacteriocidal action in addition to their bacteriostatic effect.

X. SIXTH SESSION: EVENING, MARCH 14; ABSTRACTS 51–53*

51. ADDRESS OF RETIRING PRESIDENT. *C. F. Bodecker, D.D.S., School of Dental and Oral Surgery, Columbia University, New York, N. Y.* (published on p. 191).

52. INTRODUCTION OF NEWLY ELECTED PRESIDENT. *R. W. Bunting, D.D.S., School of Dentistry, University of Michigan, Ann Arbor, Mich.* (published on p. 193).

53. REMARKS. *Philip Jay, D.D.S., School of Dentistry, University of Michigan, Ann Arbor, Mich.* (published on p. 194).

XI. ABSTRACTS OF PAPERS PRESENTED BY TITLE; ABSTRACTS 54–84

54. COMPARATIVE STUDY OF ORAL CHANGES IN DEFICIENCIES OF PANTOTHENIC ACID, NICOTINIC ACID AND THE FILTRATE FRACTION OF THE VITAMIN B COMPLEX. *Hermann Becks, Dr. med., Dr. med. dent., D.D.S., W. W. Wainwright, D.D.S., M.S., and Agnes Fay Morgan, Ph.D., College of Dentistry, University of California, San Francisco, Cal.* Recent isolation of various fractions of the vitamin B complex has made it possible to study new deficiencies in relation to certain oral lesions, which so far have been obscure etiologically. In this investigation 3 control and 7 experimental pure-bred cocker spaniels were used. The control dogs were protected against a nicotinic acid and filtrate fraction deficiency while the others were placed on diets deficient in nicotinic acid, in filtrate fraction and both nicotinic acid and filtrate fraction. The effects of administration of synthetic pantothenic acid and curative doses of filtrate fraction were also studied. The experimental period was extended from approximately 1 year

* Walter W. Wright, D.D.S., Ph.D. (University of Pittsburgh), President of Omicron Kappa Upsilon, presided at this session.

as in the previous experiment to 2 and 3 years. The oral manifestations were most pronounced and included severe changes in the epithelium of the mucous membrane and in the underlying periodontal bone structure. The changes appeared to be specific for each type of deficiency. The study confirms previous observations in these laboratories and emphasizes the importance of certain vitamin B complex fractions for the health of the oral cavity and jaw bone structure.

55. FURTHER STUDIES ON THE CALCIUM AND PHOSPHORUS CONTENT OF RESTING AND ACTIVATED SALIVA OF CARIES-FREE AND CARIES-ACTIVE INDIVIDUALS. *Hermann Becks, Dr. med., Dr. med. dent., D.D.S., W. W. Wainwright, D.D.S., M.S., and D. H. Young, D.D.S., B.S., College of Dentistry, University of California, San Francisco, Cal.* Total calcium and inorganic phosphorus were determined in salivary samples collected 1 to 3 hours after breakfast with and without paraffin activation from comparable groups of 25 caries-free and 25 caries-active individuals. Since differences in concept of clinical criteria for caries-activity and freedom, time of collection and type (resting or activated) of samples, and preliminary treatment have been considered to make comparison of previous studies difficult, studies of caries-free individuals were extended and all differences in approach eliminated. The arithmetic means of all calcium and phosphorus mg. % and mg./hr. values of resting as well as activated saliva of these 25 caries-free and 25 caries-active individuals were found to be within the same range and not significantly different according to statistical evaluation. These findings confirm the results of a previous report in which only resting saliva was used, and are in contrast to the experience of Karshan. (Published in *J. D. Res.*, **22**: 139, 1943.)

56. THE EFFECT OF MAGNESIUM DEFICIENT DIETS ON ORAL AND DENTAL STRUCTURES. IV. CHANGES IN THE PARADENTAL BONE STRUCTURE. *Hermann Becks, Dr. med., Dr. med. dent., D.D.S., and W. J. Furuta, A.B., M.S., College of Dentistry, University of California, San Francisco, Cal.* As a result of a magnesium deficient diet the skeletal structure with special reference to the alveolar bone developed marked histopathologic changes. These consisted of increased resorption and deposition leading to a mosaic appearance resembling that of an osteodystrophy. An increased amount of dark staining amorphous substance is deposited in the bone, especially near the borders; accompanied by an increased deposition of cementum on the root surfaces of the molars. These changes are first observed in animals placed on this deficient diet for 72 days and become more pronounced in animals remaining on the same diet for 186 days. The porotic condition accompanied by the deposition of amorphous substance is possibly the reason for the extremely hard and at the same time brittle nature of all bones.

57. IMPORTANCE OF LACTOBACILLUS ACIDOPHILUS INDEX DETERMINATIONS IN ORTHODONTIC PRACTICE. *Hermann Becks, Dr. med., Dr. med. dent., D.D.S., Glen Foor, D.D.S., and I. M. Shulman, D.D.S., College of Dentistry, University of California, San Francisco, Cal.* One of the most disconcerting factors in orthodontic practice is the development of rampant caries during the course of

treatment and at the time the appliances are removed. For the determination of caries activity or inactivity the *Lactobacillus acidophilus* index was used in 2 groups of children: Group I included 50 children, admitted at the orthodontic division of the school and examined before placement of orthodontic appliances. Group II included 50 children who had been under active orthodontic treatment from 1 to 3 years and examinations were made while orthodontic appliances were in place. Complete oral examinations, including the determination of the Bodecker caries index, and the *L. acidophilus* index on 3 successive days were made for Group I before active orthodontic treatment was started. This was followed by *L. acidophilus* studies at intervals of 2 to 3 months for 2 years after the appliances were placed. Group II also received a dental examination to determine the presence of any cavities or decalcified areas.

The *L. acidophilus* studies revealed that in Group I 50% of all initial counts (before orthodontic treatment was begun) were zero or low (from 1 to 300 bacilli per cc. of saliva) and 50% high, reaching in some instances more than 400,000. Quite in contrast, Group II had only 19% low and 81% high indices. When the *L. acidophilus* index of Group I was determined every 3 months during the next 2 years, the number of low indices dropped from 50% to 19.5% and the number of high indices increased to 80.5%. The tremendous increase of lactobacilli after orthodontic appliances were placed emphasizes 3 important considerations: 1. Orthodontic patients must adhere to a very strict mouth hygiene program, especially during the course of treatment because of the possibility of increased food stagnation. 2. The increase of *L. acidophilus* during orthodontic treatment increases the danger of greater caries susceptibility. 3. The *L. acidophilus* index becomes a most important tool for the determination of caries immunity or susceptibility of orthodontic patients before and during active therapy.

58. A. HUMAN SALIVA. XIII. RATE OF FLOW OF RESTING SALIVA OF HEALTHY INDIVIDUALS. *Hermann Becks, Dr. med., Dr. med. dent., D.D.S., and W. W. Wainwright, D.D.S., M.S., College of Dentistry, University of California, San Francisco, Cal.*

B. HUMAN SALIVA. XIV. TOTAL CALCIUM CONTENT OF RESTING SALIVA OF 680 HEALTHY INDIVIDUALS. *Herman Becks, Dr. med., Dr. med. dent., D.D.S., College of Dentistry, University of California, San Francisco, Cal.*

C. HUMAN SALIVA. XV. INORGANIC PHOSPHORUS CONTENT OF RESTING SALIVA OF 650 HEALTHY INDIVIDUALS. *W. W. Wainwright, D.D.S., M.S., College of Dentistry, University of California, San Francisco, Cal.*

For an analysis of the extent of variations of salivary rate of flow, mixed human saliva was obtained from 650 different healthy individuals between the ages of 5 to 95 years. The average *rate of flow* of 650 individuals was 19 ± 0.54 cc./hr. ($M \pm \sigma_m$), the standard deviation was 14 ± 0.38 cc./hr. ($\sigma \pm \sigma_0$), with a total range from 1 to 111 cc./hr. Analyses for total calcium content of mixed human resting saliva of the same 650 individuals revealed: *Total Calcium mg. %*: Male, female, and total groups showed a slow rise in the average means of 5 year age groups, reaching a maximum in the 25 to 29 year group, followed

by a plateauing. The correlation coefficient of the entire group ($r = + 0.230 \pm 0.037$) was smaller than that of the younger individuals aged 5–29 years ($r = + 0.387 \pm 0.019$). Due to the lack of definite ranges for specific age groups and the large overlapping of ranges, it is impossible to set up a normal standard for any specific age group or for the total group, and only an apparent normal range can be given for the 650 healthy individuals with a mean of 5.8 ± 0.06 mg.% and a standard deviation of 1.4 ± 0.04 mg.%. The total range of values observed was from 2.2 to 11.3 mg.%. *Total Calcium mg./hr.* The lack of relationship between total calcium mg./hr. values and age of individuals is reflected in the zero correlation coefficient ($r = \text{of } + 0.003 \pm 0.039$). In the younger individuals from 5 to 29 years the r of $+ 0.380 \pm 0.050$ was significant though slight, indicating the tendency for low calcium mg./hr. values to be found in low age groups. The results from 650 individuals gave a mean of 1.06 $\pm$ 0.03 mg./hr. and a standard deviation of 0.80 ± 0.02 mg./hr. with a total observed range from 0.12 to 6.28 mg./hr. Inorganic phosphorus analyses of mixed resting saliva of 650 healthy individuals, aged 5 to 95 years, showed: *Inorganic Phosphorus mg.%*: Averages of male and female groups by 5 year intervals increased progressively up to 50 years. The correlation between phosphorus mg.% and age was greater for the entire group of 650, r being $+ 0.344 \pm 0.034$, than for the individuals from 5 to 29 years whose r was $+ 0.189 \pm 0.051$. The averages for 650 individuals are mean = 16.8 ± 0.25 mg.%. *Inorganic Phosphorus mg./hr.:* The lowest average mg./hr. value is again found at 5 to 9 years. The averages of older groups do not differ significantly from each other. The wide range of results is reflected in the lack of correlation between phosphorus mg./hr. and age in the entire group ($r = + 0.125 \pm 0.038$). The mean of all inorganic phosphorus mg./hr. values is 3.1 ± 0.07 mg./hr., the standard deviation is 1.9 ± 0.05 and the total observed range is from 0.2 to 16.7 mg./hr.

59. FACTORS INFLUENCING THE REDUCTION OF ENAMEL SOLUBILITY BY FLUORIDES. *B. G. Bibby, B.D.S., Ph.D., Tufts Dental College, Boston, Mass.* In order to indicate the possibility of obtaining a reduction of enamel solubility by the use of fluoride containing dentifrices, the effects of various fluoride containing mixtures on enamel solubility were tested in the laboratory. Enamel solubility was estimated by the weight loss from a sample of pure enamel when subjected to the action of pH 4 buffer for a period of 15 minutes. Comparison of the weight loss after treatment with fluoride and fluoride mixtures provided an estimate of their effectiveness in changing enamel solubility. 1/1000 sodium fluoride reduced the solubility of 3 samples of enamel to 65.7, 65.8 and 71.5% of the buffer solubility. When the fluoride was mixed with calcium phosphate, sodium carbonate or magnesium carbonate, there was a lessened reduction of solubility. Several wetting agents also interfered with the solubility reducing effect of sodium fluoride. 1/1000 and 1/10,000 and 1/100,000 sodium fluoride in saliva were as effective as the same concentrations of fluoride in water. Thirteen commercial dentifrices were mixed with fluorides. None of these mixtures significantly influenced the solubility of the enamel.

60. THE RELATIONSHIP BETWEEN MICROSCOPIC HYPOPLASIA (MELLANBY) AND DENTAL CARIES. *B. G. Bibby, B.D.S., Ph.D., Tufts Dental College, Boston, Mass.* To check the claims of Mellanby and her associates that minute differences in the roughness of the enamel surface (microscopic hypoplasia of Mellanby) are related to susceptibility of teeth to caries a correlation was made between the enamel surface texture and the amount of caries in the teeth of 200 children. Half of the children, age 10 to 13, lived at home, and half, age 6 to 16, were in an orphanage. The microscopic hypoplasia estimates were made by means of a probe and visual examination. In the first group, 2 or 3 estimates were made at different times and the results averaged; in the latter group only one estimate was made. Caries examinations were carried out with a mirror and probe. In the school group 52 children with microscopic hypoplasia of the incisors estimated as Hy 0–1 averaged 11.65 cavities in their permanent and deciduous teeth; 39 with incisor Hy 1–2 averaged 13.56; 8 with Hy 2–3 averaged 16.88; 1 with Hy 3–4 had 21 cavities. In the orphanage group, the figures were: 23 with Hy 0–1, 10.48 cavities; 32 with Hy 1–2, 10.75; 30 with Hy 2–3, 10.98; 7 with Hy 3–4, 11.43. In the school group the correlation between microscopic hypoplasia of the molars closely paralleled findings in the incisors. There was an indefinite parallel between caries of the permanent teeth and M. hypoplasia of the incisors. There was little apparent correlation between M. hypoplasia in the school group and the increase of caries over 2 years. The findings support the claims of Mellanby and others that there was a correlation between the minute surface structure of the teeth and the liability of the teeth to decay.

61. BACTERIAL GROWTH AND ACID PRODUCTION IN SALIVA. *B. G. Bibby, B.D.S., Ph.D., and Irene MacKinnon, Tufts Dental College, Boston, Mass.* To indicate whether acid production by salivary organisms was most closely related to the total bacterial count, the streptococcal count, the lactobacillus count or the rate of growth of these organisms, tests were made on the salivas of 15 patients with low caries, 13 with high caries and 7 with moderate caries. One per cent glucose was added to 2 aliquots of paraffin-stimulated saliva one of which was incubated in the ordinary way at 37°C, the other of which was mechanically agitated during incubation. Hemocytometer, (total bacteria), oatmeal bread culture (streptococcus) and tomato juice agar culture (lactobacillus) counts were made at the beginning of the experiment and at 4 hours, 8 hours and 24 hours afterwards. The pH was measured colorimetrically at each interval and acid titration made at 8 and 24 hours. In non-agitated tests acid production was most rapid during the first 8 hours but continued for the duration of the tests. The total bacterial count and the lactobacillus counts showed, especially in the low caries tests, accelerated growth after 8 hours, whereas the streptococcal population reached its high point at 4 hours and decreased thereafter. The growth curves and acid production curves were roughly parallel in the high, medium and low caries and descended in that order. In the agitated tests the total acid production was higher in all series. The lactobacilli grew much less rapidly (with practically no growth in the low caries tests) and the streptococcal count fell off more markedly, but in all the

general direction of changes were the same. Higher acid production was associated with higher bacterial counts (total bacteria lactobacilli and streptococci). The only relationship between rate of bacterial growth and acid production appeared to be between the rapid growth of streptococci and rapid acid production during the initial hours of the tests.

62. THE INFLUENCE OF VITAMIN D ON THE STRUCTURE OF THE TEETH AND BONES ON LOW CALCIUM DIETS. *Paul E. Boyle, D.M.D. and Laurence G. Wesson, Ph.D., Harvard School of Dental Medicine and the Forsyth Dental Infirmary, Boston, Mass.* Four groups of rats (6 animals in each group) were maintained for 1 year on diets low in calcium. Two diets were used: one high in protein and the other high in carbohydrates. The calcium/phosphorus ratio of both diets was approximately 1 to 16. Half of the animals on each diet were given 272 International Units of vitamin D per 100 grams of diet. Vitamin D was markedly effective with the high carbohydrate-low calcium diet in promoting the growth and survival of the rats and in appreciably improving their appetite, calcium retention, and the degree of calcification of their bones. Vitamin D was ineffective in these respects with the high protein-low calcium diet. Vitamin D was effective in improving the histological structure of bones and teeth with both the high protein-low calcium and the high carbohydrate-low calcium diets. The teeth of animals on both vitamin-deficient diets were characterized by a wide uncalcified predentin and a globular calcification of the dentin, whereas the teeth of animals on the vitamin D supplemented diets were histologically almost normal. The orange-yellow pigment of the exposed enamel was normal in intensity in the teeth of the vitamin D supplemented animals, while in those not receiving vitamin D the enamel varied from an opaque white to a blotchy yellow. The bone trabeculae of animals on either of the diets, with or without supplemental vitamin D, showed little or no osteoid formation. The bone shafts and bony trabeculae of animals on the vitamin D supplemented diets were atrophic, but otherwise almost normal. The bony structures of animals on the vitamin D deficient diets showed active resorption and reformation with the production of fibrous marrow spaces which simulated the "osteitis fibrosa" of hyperparathyroidism. It is suggested that this process may be explained on the basis of formation of functionally inadequate bone.

63. ALTERATION OF OCCLUSAL RELATIONS INDUCED BY EXPERIMENTAL PROCEDURE. *Carl Breitner, M.D., D.D.S., New York, N. Y.* Current orthodontic literature reiterates the contention that the inherited growth pattern determines the form of the human jaws and that the jaw bones therefore cannot be modified or influenced. Effective influence of any orthodontic treatment, according to this contention, is restricted to the alveolar bone (Brodie, Broadbent, Hellman, Thompson, Mershon, Jackson). The acceptance of the concept limits improvement in orthodontic therapy to the perfecting of mechanical, tooth-moving devices. Most important, if the concept is fallacious, it precludes (if accepted) any clarification of the origin of dental and facial malformations, as well as the improvement in the methods of their correction. Generally accepted laws of biology do not support the theory of immutability, but rather make it dubious

(Roux, Darwin, Russel, Angle, Case, Baker). Recently, new, clinical proof has been added to previously published microscopic evidence that bone changes can be induced in extra-alveolar areas. In a mature Macacus rhesus a complete and lasting change in occlusal relations was created without applying any forces to the teeth or to the alveolar process. No mechanical device was used, but by paralyzing masticatory muscles, an Angle Class III malocclusion was created in a previously normal animal within 72 days. This malocclusion has persisted for 18 months to date, long after recuperation of the affected muscles. The opposite result, namely an Angle II malocclusion, was created in another animal through a converse procedure. The experiments corroborate previously published histologic evidence of induced extra-alveolar bone transformations. The experiments suggest one possible cause of dental malformations, namely, a disharmony between muscular forces and architecture of the bone. The experiments point toward a possible way of influencing the occlusion, without employing appliances or similar conventional apparatus. The experiments elucidate the necessity, in attempting improvement of orthodontic therapy, not of concentrating upon mechanical devices but rather of seeking means of modifying the skeleton.

64. A SIMPLE TINCTORIAL TEST FOR THE CLINICAL DIAGNOSIS OF LEUKOPLAKIA. *Lester W. Burket, D.D.S., M.D., University of Pennsylvania Dental School, Philadelphia, Pa.* Schiller's test for detecting early malignant changes of the cervix uteri has been adapted for use on the oral mucosa. This test is based on the fact that glycogen containing cells stain a mahogany brown-red. Ordinary Lugol's solution is painted on the suspected lesion and the adjacent mucosa and allowed to remain for 3 to 5 minutes after which the mouth is rinsed. Leukoplakic areas fail to take the stain and remain a whitish-yellow color in contrast to the deeply stained normal mucosal. Oral mucosal lesions of traumatic origin stain a deeper color than the normal mucosa. This test is only a clinical aid to diagnosis.

65. CHANGES IN THE CARBONATE CONTENT OF PIG ENAMEL DURING CALCIFICATION. *R. L. Burt, M.S., Ph.D., and Martin Deakins, D.D.S., Ph.D., Harvard School of Dental Medicine, Boston, Mass.* The carbonate (CO_3) content of unerupted pig enamel at various stages of calcification was determined. The results, expressed on a volumetric basis, showed that the carbonate increased linearly from 0.03 to 0.11 mg. per cu.mm. as the total ash increased from 0.06 to 2.70 mg. per cu.mm. When the carbonate was calculated in percentage of the dry weight of the total ash, the values decreased from 5% to 4% during the same increase of ash.

66. DEGENERATIVE CHANGES IN SO-CALLED MIXED TUMORS OF THE SALIVARY GLANDS. *Virgil D. Cheyne, D.D.S., Ph.D., Indiana University School of Dentistry, Indianapolis, Ind.* Mixed tumors which arise in salivary tissue must be differentiated from inflammatory processes, cysts and root granulomas. A study of 48 cases of mixed tumors treated at Indiana University Medical Center reveals that clinically they undergo a long period of painless growth. Histologically, the neoplastic element is an indifferent epithelial cell which possesses the

ability to undergo marked metaplasia and secrete a myxomatous material thus accounting for the peculiar features encountered. Early tumors are markedly cellular; older tumors show an excessive accumulation of the mucoid material which spreads the cells apart. It is loosely fibrillar and slightly basophilic. It compresses the neoplastic and stroma elements causing atrophy, degeneration and diminished blood supply. Fluid accumulation in the cells and mucoid material is the first evidence of the degeneration. As this increases the tissue assumes the appearance of a net, not unlike reticular degeneration encountered in old or damaged tooth pulps. Fluid accumulations may even form large cysts lined by neoplastic epithelium. Cartilageneous-like structures make their appearance near the central portions of old tumors as a result of metasplastic change in the epithelial cells and their product. The interstitial substance is homogeneous and surrounds the epithelial cells to form chondrocyte-like elements. True cartilage, or even bone, infrequently forms as a result of hyalinization and metaplasia of the epithelial elements and their supporting connective tissue. Some infiltration by lymphocytes, and plasma cells, old and recent hemorrhage, and areas of fat are also common findings.

67. TOXICITY OF VITAMIN K (2-METHYL-1,4-NAPHTHOQUINONE). *A. F. Dodds, M.S., L. S. Fosdick, Ph.D., E. H. Hatton, M.D., and G. W. Rapp, M.S., Northwestern University Dental School, Chicago, Ill.* White rats were fed 2-methyl-1,4-naphthoquinone in the following amounts per day; the substance was added to the food and full consumption insured by limiting the amount of food supplied to a little less than would be fully utilized; to 1 group of 10 rats, 25 mgms; to a second, 10 mgms.; and to a third, 1 mgm.; a fourth group identically fed, receiving none of the drug, was used as a control. Selected descendants of animals used in each of the 4 groups were used in groups of 10 to test the toxicity of the preparation. Similarly a third generation, chosen from descendants of the second, was fed the vitamin preparation. The first generation was on the experimental period for 57 weeks, the second for 45 weeks, and the third for 25 to 35 weeks. The first generation was full grown at the beginning of the experimental period, the second and third, about 35 days old. There is no significant variation in the pattern of the weight and growth curves of all 4 groups, although the control groups produce patterns that seem a trifle more favorable. All animals dying during the course of the experiment were carefully examined by dissection and selected organs and tissues by histological methods. The remainder were killed at the end of the experimental period and their bodies submitted to similar examinations. Except for a tendency for the yellow and orange shades of color to predominate in the animals on the experimental diet, none of the pathological changes found in any of the animals can be ascribed to the consumption of vitamin K.

68. DENTINOGENESIS: HISTOLOGIC STUDY OF THE DEVELOPMENT OF THE DENTIN IN THE CAT. *H. E. Frisbie, D.D.S., and James Nuckolls, D.D.S., University of California, College of Dentistry, San Francisco, Cal.* The development and calcification of dentin has been studied. For the greater part variously stained sections of the undecalcified tooth bud of the young cat were used. Differential staining of zones of the dentin matrix has been obtained, showing

a predentin and intermediate zone and a calcified matrix. In the early calcifying dentin an additional intermediate and an uncalcified zone similar in staining properties to the pulpal region of dentin has been observed beneath the dentino-enamel junction. The relationship between Korff's fibers and the walls of tubules and their branches has been established. Dentinal fibril-tubule relationship has been studied.

69. DEVELOPMENT AND FUNCTION OF THE ORGANIC MATTER OF THE ENAMEL. *B. Gottlieb, M.D., Baylor University, College of Dentistry, Dallas, Tex.* The fresh fixation of freshly formed enamel matrix to the dentin is accomplished by the dentino-enamel membrane (Saunders, Nuckols and Frisbie). The freshly deposited enamel matrix shows some fixation to the dentin. The older layers of matrix tend to separate from the dentin, shrinking in routine histological technic, including decalcification. At this stage the separated surfaces of dentin and enamel matrix are smooth. In later stages of matrix formation fibres belonging to the enamel remain attached to the dentin and are torn out from the matrix if separated from dentin by shrinkage. The connection of the dentin with the organic prism sheaths becomes stronger and that with the more calcified parts of the enamel apparently weaker. These organic fibres arranged in groups appear to be identical with the tufts seen in ground sections. They fix the maturing and mature enamel to the dentin. The prism sheaths throughout the enamel fix the more calcified parts of the enamel to each other (vonEbner). After dissolution of enamel of mature teeth by decalcification in protected places, a continuous brush of fibres of the enamel remaining in connection with the surface of the dentin are the fixing fibres of enamel to the dentin partly arranged in groups (tufts) partly existing as isolated fibres (prism sheaths). The lamellae are products of particular developmental conditions. One kind consists of prism groups which remained in the matrix stage (Orban). The other kind, which sometimes extends into the dentin, develops from cracks in the calcifying enamel, into which surrounding tissue has penetrated (Gottlieb). The lamellae seem to have no physiologic function. All organic substance of the enamel however is important in developing and spreading of dental caries. (Published in *J. D. Res.*, **22**: 185, 1943.)

70. FORMATION OF THE ENAMEL PRISMS. *B. Gottlieb, M.D., Baylor University College of Dentistry, Dallas, Tex.* The course of the prisms on the surface of the enamel is more or less parallel. In thin layers of enamel they usually run parallel from the dentin to the surface. In thick layers the middle, and sometimes the dentinal parts, are found to traverse such different courses from neighboring prism groups that one can hardly imagine that each prism is formed by one single ameloblast throughout. The freshly formed enamel does not show any structure (von Ebner and others). After some time prisms crystallize from the homogeneous mass. In most places that crystallization follows the course of the pre-enamel and the prisms run parallel. In places with thick enamel, some homogeneous areas may crystallize independently from the course of the pre-enamel following the shape of the other prisms. The crystallization of the

homogeneous mass into prisms happens apparently as soon as a certain degree of calcification is reached. It consists of a higher calcification of the main part (prism) and lack of additional calcification of threads between them (prism sheaths). By such differentiation individual prisms are formed. Corresponding to the progress of calcification the prisms are formed in the later matrix stage.

71. THE MICROBIC FLORA OF DENTAL PLAQUES IN RELATION TO THE BEGINNING OF CARIES. *Elizabeth S. Hemmens, Ph.D., J. R. Blayney, D.D.S., M.S., R. W. Harrison, Ph.D., and S. F. Bradel, D.D.S. Walter G. Zoller Memorial Dental Clinic, and the Department of Bacteriology, University of Chicago, Chicago, Ill.* Changes in the cultivable bacterial flora of plaques, associated with the appearance of caries, have been determined for 56 tooth surfaces by means of cultures made on acid (pH 5.0) and neutral media every 6 weeks from the time of eruption of the teeth until caries was established. It is not possible from the results to state that any of the cultivable microorganisms is the cause of caries but a number of types showed an increase in incidence with the appearance of the lesion. The most marked increase was in the lactobacilli while beta hemolytic streptococci, small gram positive rods, rough colony alpha type streptococci and aciduric streptococci showed increases of lesser degrees. A number of microorganisms, including fusiform bacilli, smooth colony, alpha type streptococci and filamentous rods decreased in incidence with the appearance of caries.

72. DIFFERENT DEGREES OF HARDNESS OF DIFFERENTLY SITUATED ENAMEL LAYERS. *E. C. Hinds, D.D.S., School of Dentistry, Baylor University, Dallas, Tex.* In our experiments the hardness of both unerupted and erupted teeth, that is, teeth which had been exposed to the mouth fluids and teeth which had not, were checked. This included the erupted and non-erupted portions of deciduous teeth. Results showed no apparent difference in the hardness of erupted and unerupted teeth. These findings do not prove that the saliva has no effect on the tooth substance but only shows that it does not affect tooth hardness. We may continue to assume that some change, the nature of which is unknown, does take place in the enamel with the passing of time, because of the evidence of increased resistance of enamel to decay in older people. That change is probably not one of an appreciable increased calcium content. It was found that in some cases very young or even deciduous teeth were harder than older teeth. It has been shown by Diamond and Weinmann that the enamel matrix is completely formed before maturation takes place and that about 30% of this enamel matrix is organic matter (Weinmann, Wessinger, and Reed). The process of maturation includes then a reduction in the amount of organic matter present, and an increase in the amount of calcium and phosphorus. The whole thickness of the enamel must be included, and so it seems that the enamel most remote from the surface would have the most difficulty in getting rid of the water and organic matter and taking in more calcium and phosphorus. This might explain the difference in hardness between the outer and inner layers of enamel.

73. COMPARATIVE STUDY OF X-RAY, MACROSCOPIC, AND MICROSCOPICAL FINDINGS OF INCIPIENT CARIES. *F. W. Hinds,* D.D.S., School of Dentistry, Baylor University, Dallas, Tex.* Extracted teeth with intact contact planes showing some discoloration were selected and photographed. X-ray pictures in buccolingual direction were made and afterwards sections were ground mesio-distally in order to investigate microscopically how far caries had developed. Presence of yellow stain was the indicator of the extent of dental caries. In many cases the carious process had already affected the dentin without the X-ray picture showing any involvement in either the dentin or the enamel. These findings permit the conclusion, that positive X-ray findings in examination of teeth for caries indicates the necessity of filling such areas without delay regardless of size or extent. Such findings can only be explained by the fact that the principle of the carious process is not decalcification but invasion of microorganisms into the organic matter of the tooth.

74. DENTAL CARIES—THE "HANDWRITING" IN THE MOUTH. *Martha R. Jones, Ph.D., San Francisco, Calif.* An imbalance in nutrition characterized, in part, by a reduced titratable alkalinity of, and presence of hitherto nonexistent enzymes in the blood and tissue fluids, appears to be the "common denominator" of many of the physical ills of modern man. Concomitant are: accelerated rate of calcification of bone, and rate of growth of acid-forming bacteria in the mouth (dental caries); lowered resistance to disease; and adaptive changes in cells, organs and blood vessels which give rise to many seemingly unrelated body ailments. Thus, decaying teeth are danger signals—the "handwriting" in the mouth —which warn one of his vulnerability to bacterial and other diseases. This imbalance may be the resultant of many factors as: spurts in growth and development; pregnancy; disease; physical and mental strain; over-exposure to heat and sunshine; over-dosing with vitamin D in any form, and growth-promoting diets that are acid-forming or too low in potential alkalinity to prevent loss of base from the blood. Dental caries activity in a so-called "normal" individual whose diet is rich in minerals, vitamins and other essential nutrients is interpreted as a need for more of the alkali-rich, green leaves and grasses (natural sugar and sorghum cane juices) and other base-forming foods in his diet, and less, perhaps, of the acid-forming meats, grains, eggs and refined sugars. *Too much* of the base-forming varieties is as damaging to bone as *too little* is to teeth. Both extremes undermine health and shorten life.

75. THE SOLDIER'S MESS IN RELATION TO DENTAL CARIES. *Martha R. Jones, Ph.D., San Francisco, Calif.* According to official reports, "Army Field Ration A," 1942, the midshipmen's ration, 1937, and that of the enlisted men at the Pearl Harbor Submarine Base, Hawaii, 1935, contained the following kinds and amounts of foods, respectively: meats, *15.0 oz.*, 15.0, 17.2; eggs, *1*, 1½, 1; whole milk or equivalent, *17.5 oz.*, 41.2, 11.7; butter, *1.44 oz.*, 3.49, 1.37; bread or equivalent, *12.1 oz.*, 11.7, 10.8; citrus fruit and tomato, *3.0 oz.*, 9.7, 5.8; leaf, green and yellow vegetables, *7.0 oz.*, 10.1, 9.1; other canned and fresh vegetables,

* Deceased.

17.0 oz., 18.5, 19.1; other canned and fresh fruits, *6.5 oz.*, 10.9, 6.7; sugar, syrup, etc., *4.8 oz.*, 7.0, 4.4. All 3 rations were "adequate" in all known essential nutrients, scored by accepted rules of nutrition—the midshipmen's being exceptionally rich in protein, calcium, phosphorus, iron and vitamins. In respect to potential reaction, "Army Field Ration A" was calculated to yield an excess of 0.54 cc. normal acid per 1000 calories, and the midshipmen's and enlisted men's, 7.2 and 5.2 cc., respectively, of normal alkali. The incidence of caries in the group of 109 enlisted men (average age 28¾ yrs.) was 98.2%—the average number of defects per man increasing from 12.63 to 15.6 during the 6 to 12 months period studied. In the 328 midshipmen (1937 class) the incidence of caries was 96.0% on admission to the Academy (18 years of age) and 98.5% at the time of graduation. Dental defects in the average man increased from 12.46 (17.69 tooth areas) to 22.42 (32.31 areas). The yearly increase of 3.65 carious tooth areas per man is 3 times that reported found in comparable civilian groups, and nearly 2½ times the average yearly increase experienced by the men themselves from their 6th to 18th year of age. In all groups studied, the potential alkalinity of an otherwise "adequate" diet has *invariably* been found to bear an *inverse relationship* to the incidence of caries. The high rate of tooth decay in the midshipmen and enlisted men is attributed to the combined effects of their low alkaline ash ration and other factors incident to military life which tend to lower the blood's base reserves. It is to be expected that actual war plus the acidity of "Army Field Ration A" (1942 type) will further increase the rate of tooth decay and incidence of related ills in our fighting forces.

76. ANTHROPOLOGICAL STUDIES IN DENTAL CARIES. *Meyer Klatsky, D.D.S., and Jack S. Klatell, B.S., D.D.S., Sea View Hospital, Staten Island, N. Y.* The object of this study was to investigate the comparative incidence of dental caries among various peoples, ancient and modern, primitive and civilized. 4000 skulls and their 38,300 teeth were examined at the anthropological section of the American Museum of Natural History, New York. These skulls were collected from all parts of the globe, and represent different racial, national and territorial groups and all ages. The collections are arranged geographically. The major part of 46 of these geographical groups was examined. The number of teeth in each group was counted, and each tooth was carefully checked for caries. Of the 46 geographical groups, the following six showed no caries: Eskimo, British Columbia, Chatham Island, Hawaii, Siberia, and Patagonia. All the other groups showed various degrees of caries, ranging from 0.3% in the New Guinea group to 34% in the Yugo-Slav group. Ancient and primitive peoples showed a low incidence of caries, the percentage rising in the modern and civilized groups. These groups with a lower caries index possessed well developed jaw bones, with full bony ridges and prominences for the attachment of the masticatory musculature. Their teeth were worn and flattened by attrition. These are both evidences of complete masticatory function. And there seems to be an inverse relation between masticatory function and the incidence of dental caries. (To be published in *J. D. Res.*)

77. THE MECHANISM BY WHICH IODOACETIC ACID INHIBITS EXPERIMENTAL

DENTAL CARIES IN THE RAT. *Vernon H. Powell, D.D.S., and Peter P. Dale, D.M.D., University of Rochester, School of Medicine and Dentistry, Rochester, N.Y.* Iodoacetic acid given in the food and/or drinking water appears to inhibit experimental dental caries in the rat. However, its mechanism of action in this regard has not been described. To determine the possibility that the presence of iodoacetic acid in the saliva may be responsible for its action, the salivary glands of 21 rats were removed. Eleven were maintained on distilled water and the Hoppert-Webber-Canniff caries-producing diet. Ten received in addition 200 p.p.m. of iodoacetic acid in the food. The desalivated animals which did not receive iodoacetic acid had a caries score about 50 percent higher than that of a group of non-desalivated controls. The desalivated animals which received iodoacetic acid in the food revealed a marked reduction in carious lesions comparable to that observed in non-desalivated rats maintained on the caries producing diet supplemented by 200 p.p.m. of iodoacetic acid in the drinking water or by periodic injections of iodoacetic acid. Desalivation probably has little effect in altering the action of iodoacetic acid in inhibiting caries. Unlike fluorine, iodoacetic acid administered parenterally has a definite ability to reduce the incidence of experimental carious lesions in the rat. (To be published in *J. D. Res.*)

78. HEREDITARY TRANSMISSION OF GRADUALLY DEVELOPED DENTAL CHARACTERISTICS. *Samuel Rabkin, D.D.S., Cincinnati, Ohio.* Evidence from skulls of different groups of early man exhibit diversity in physical and dental morphology. Differences in pattern, shape and size of teeth, palates and jaws were entrenched traits in man long ago. Established modifications in the dentition were retained long among prehistoric man and also among living primitive peoples. The genetic traits developed in human ontogeny, both the characteristics of ancestral prototypes and acquired transitory modifications, have been transmitted variously among different individuals. It is well known that australoid, negroid and mongoloid types have retained their respective entities. The prehistoric American Indian remained free from admixture until the European migrated to the Americas. Among the dental aberrations observable among the remains of the American Indian are: tendency toward torsion of the incisor teeth, shovel-shaped pattern of the maxillary incisors, broad second incisors and bulging contact surfaces of the characteristically large molars. The development of the alveolar support is marked and a buccal marginal ridge is frequently observed at the alveolar border of the mandible extending from the last molar to the first premolar. Civilization and transplantation of population, changes in food habits, and adverse environmental influences have largely contributed toward physical and dental alterations. These and random matings have contributed to degeneration changes and decline. However, genetic influences result in the appearance of large bulging molars, cingulae, shovel-shaped incisors and occasionally torsion in modern man representing reintroduction from ancestral prototypes. Gradually developed traits, good or bad, will be continually transmitted to succeeding generations.

79. FREQUENCY OF ALLERGY IN ORTHODONTIC PATIENTS. *Walter Straub, D.D.S., M.S., College of Dentistry, University of California, San Francisco, Cal.*

The observation of allergic manifestations in the oral cavity prompted this investigation to determine the frequency of allergy in patients applying for orthodontic therapy. One hundred and four children submitted to a medical examination with metabolic studies as well as urine and blood analyses. Scratch and intradermal tests were made and detailed family and personal histories were taken. Other studies included thorough oral examinations for allergic manifestations (gingivitis, etc.), type of malocclusion, and determination of the *Lactobacillus acidophilus* index. The medical examination revealed a number of abnormal conditions not necessarily related to an allergic tendency. Approximately 40% of all individuals examined had high eosinophile counts. The family and personal histories as well as the scratch and intradermal tests uncovered a large number of allergic individuals: 40% were definitely allergic, 12% were borderline cases and 48% were negative. Sixty-three per cent had contracted maxillary arches with the accompanying protraction of the anterior teeth and retraction of the mandible and mandibular teeth. In 17% of the allergic patients a pronounced gingivitis was found. There was no difference in the results of the *Lactobacillus acidophilus* indices of allergic and non allergic individuals. It appears from this study that the medical and dental profession should direct their attention to the early recognition of chronic nasal or respiratory allergy as an important factor in the etiology of dentofacial anomalies, especially the Class 2 Division 1 type.

80. PREPARATION OF ENAMEL WALLS IN CAVITY PREPARATION. *Edmund V. Street, D.D.S., University of California, College of Dentistry, San Francisco, Cal.* A laboratory study has been made to determine the effects produced upon the enamel walls of extracted teeth when cut with various types of burs, stones, disks and chisels, at varying speeds of rotation and under wet and dry conditions.

81. THE EFFECTS OF VARIOUS FACTORS ON THE ELIMINATION FROM THE MOUTH OF ARTIFICIALLY INOCULATED YEAST. *S. Turesky, A.B., D.M.D., B. G. Bibby, B.D.S., Ph.D., and Irene MacKinnon, A.B., Tufts Dental College, Boston, Mass.* Tests on the elimination of artificially introduced yeast from the mouth confirmed the findings reported by Knighton. In descending order, chewing apples, sticky candy, chewing gum, paraffin and peach were more effective than toothbrushing in cleaning the mouth. Preliminary tests indicate that carrot and bread and butter greatly aided but that prior use of mineral oil interfered with the cleansing mechanisms of the mouth. The rate of salivary flow and other intrinsic factors seemed to be of more importance in determining the rate of removal of yeast than the nature of the cleansing agents used on a toothbrush.

82. COMPARATIVE HISTOPATHOLOGIC CHANGES IN PULP AND DENTIN UNDER VARIOUS ZINC OXIDE CEMENTS. *Charles F. Vallotton, M.D., D.D.S., The Northwestern University Dental School, Chicago, Ill.* The comparative protective action of 3 zinc oxide cements used as cavity fillings was investigated. Gingival cavities were prepared in monkey, dog, and human teeth with similar operative procedure and comparable extension. The cavities were filled with the following cements mixed with a constant liquid powder ratio: (A) zinc oxide and eugenol, (B) improved zinc oxide and eugenol (containing rosin, kaolin, magnesium oxide,

silver acetate, and olive oil), and (C) Pulprotex. The teeth were removed 1, 14, 60 and 180 days postoperatively and histologic sections prepared. With the exception of very deep cavities under which pulpal damage was the rule, no secondary dentin formation or pulpal reaction were observed under A, occasional slight secondary formation and no pulpal damage under B, and constant, somewhat greater secondary formation under C. Control human teeth in which cotton was sealed into cavities with oxyphosphate cement not in contact with the cavity floor showed marked changes in the predentin layer as early as 14 days after preparation. Human and monkey teeth reacted identically. Atypical changes were observed in the dentin of dog teeth.

83. Observations on the adsorption of fluoride by the enamel. *J. F. Volker, D.D.S., Ph.D., J. Bonner, M.S. and F. Brudevold, D.D.S., Tufts College Dental School, Boston, Mass.* Previous experiments have shown that fluorides in aqueous solution combine with powdered enamel and that the reaction is true adsorption. The present investigation was undertaken to study the adsorption of fluoride from aqueous solutions containing alkyl sulfate. The experimental technique was essentially that reported previously. It was found that fluorides were readily absorbed from aqueous solutions containing alkyl sulfate, although the adsorption was not quite so great as that found in aqueous solutions alone. When the acid solubility of the enamel samples that had been exposed to the fluoride alkyl sulfate solutions was tested it was found to be significantly reduced. These findings indicate the possibility of attempting to reduce caries susceptibility by means of a dentrifice containing soluble fluoride and alkyl sulfate.

84. Relation between oral hygiene and bismuth pigmentation. *H. A. Zander, M.S., D.D.S., Tufts Dental College, Boston, Mass.* The mouths of 200 dentulous luetic patients receiving treatment with bismuth salicylate were examined. In 67 cases calculus and gingivitis were associated with bismuth pigmentation. The number of bismuth injections given in each case varied from 4 to 304, the average for this group being 39.4 injections. 108 cases showed the presence of calculus and gingivitis but no evidence of bismuth pigmentation could be found. In this group the number of injections varied from 3 to 199, the average being 35.5 injections. 25 cases presented no evidence of either calculus and gingivitis or bismuth pigmentation. The number of bismuth injections received by this group ranged from 1 to 92 with an average of 32.1 injections. The slight difference in the average amount of bismuth given in the 3 groups does not explain the presence or absence of bismuth pigmentation. The findings suggest that the presence of calculus and gingivitis does not determine the appearance of bismuth pigmentation.

XII. Necrology

Knud-Mogens Christopherson, p. 228; Carl J. Grove, p. 229; Herbert A. Potts, p. 229

Knud-Mogens Christopherson: 1914–1942

Knud-Mogens Christopherson was elected to membership in this Association in March, 1940 at the Eighteenth General Meeting in Philadelphia.

His untimely death cut short a very promising career. He had already done fruitful research in the field of paleopathology and was the author of significant articles in the Scandinavian and English scientific journals. He was instructor in operative dentistry in the Dental Institute at Copenhagen and engaged in private practice of dentistry.

He was born August 20, 1914 in Copenhagen and died in the Community Hospital in Copenhagen, April 21, 1942.

CARL J. GROVE: 1873–1942

Dr. Grove was elected to membership in this Association at the Sixth General Meeting, held in Washington, D. C., in 1928. He was one of the founders of the Minnesota Section. He rarely attended the general meetings but in 1931, 1933, 1935 and 1940 he submitted items for the program which were read by title and appeared in the proceedings in abstract form.

He and John P. Buckley were both pharmacists and roomed together as dental students. Common interest and training naturally lead them into therapeutics and especially its application to root canal treatments. Grove was also deeply interested in the tissue reactions to disease and therapy and studied carefully by histological methods the reactions of the periodental tissues especially the tendency of the periodental tissues to invaginate into the apical opening of the root canal. Later studies had to do with saliva and dental caries, particularly the ammonia content of the former.

Grove was born at Milleville, Minnesota. After high school he studied pharmacy at Valpariso, dentistry at the Chicago College of Dental Surgery where he received the D.D.S. degree in 1898. He located at once in Southern Minnesota and later (1904) in St. Paul. For a time he was editor of *Nutrition and Dental Health.*

He passed away on July 4th, 1942. He is survived by a widow (Loula B. Grove), one son with whom he was associated in the practice of dentistry, two brothers and one sister.

HERBERT A. POTTS: 1873–1942

Dr. Potts was one of the original members of the Chicago Section and participated in the early activities of Association. His name appears only once on the programs of the general meetings (March, 1929).

As a student and beginning practitioner he came successively under the influences of G. V. Black, John B. Murphy (a distinguished Chicago general surgeon) and Thomas L. Gilmer. Of the three, it would seem that Murphy influenced him the most, especially in his teaching and professional objectives. In oral surgery he found a congenial field for the exercise of his great ability and the attainment of his professional and educational objectives.

He was born in Green Co., Ill., entered Northwestern University Dental School from high school, graduating in 1895. After a brief experience in dental practice he returned to Northwestern and received his M.D. degree in 1901. A long apprenticeship in hospitals was capped by study abroad at Bonn and Vienna,

especially in pathology and anesthesia just at the time that vital studies in local anesthesia were in progress. He returned to Chicago in 1908, became a member of the faculty of Northwestern University Dental School, at first in the subject of pathology and in 1920 was transferred to oral surgery. As a major he served in France in the first World War as consulting oral surgeon to a group of hospitals.

He died October 7, 1942 at his home in Evanston, Ill., after a long illness and is survived by his widow, Anne S. Potts, and two children.

XIII. Executive Proceedings

A. Report of the Secretary-Treasurer

Saturday Morning Session, March 13th, 1943. Minutes of the Twentieth General Session were submitted as printed in the June, 1942 number of the Journal of Dental Research and approved without a reading.

M. K. Hine and W. R. Schram were appointed tellers to receive and count the votes as recorded on the official ballot-forms and to report at the Sunday afternoon executive session.

The Secretary-treasurer reported that during the current Association year members George L. Bean, Boyd Gardner, Robert W. Rule, Genevieve Foley and Paul J. Hanzlik had resigned. Also that section secretaries have indicated that Homer C. Brown, Alden Bush, H. Shirley Dwyer and Frederick S. Meyer had been dropped from section lists for non-payment of dues, both local and general. Four members have been lost by death, Carl J. Grove, Herbert A. Potts, George H. Wright (Charter member) and Knud-Mogens Christopherson.

The Secretary-treasurer collected $640.10 during the year for dues and subscriptions to the Journal of Dental Research. He paid the treasurer of the Journal and local secretaries $268.00 and spent $361.24 for the most part for postage and stationery. The Dental Science and Dental Art Grant-in-Aid Fund was increased by the addition of $40.47 by the original donors and by a small amount of interest. A William J. Gies Endowment Fund of $1292.95 was transferred to the Secretary-treasurer soon after the New York meeting by B. B. Palmer, the former treasurer, the greater part of it was immediately invested in U. S. Bonds. As of March 12, 1943, there was on hand in cash (in bank) or in securities as follows:

In general fund	$686.79
In Dental Science and Dental Art Grant-in-aid	307.16
In William J. Gies Fund	1307.95

The Secretary-treasurer reported that the Council during the current Association year had: 1. Approved plan adopted by the trustees of the investment of Association funds in U. S. bonds. 2. Elected R. Gordon Agnew, George B. Pritchard and J. C. Middleton Shaw, honorary vice-presidents for the 1942–1943 year. 3. Selected Chicago, the Drake Hotel and March 13 and 14 as the place and time of the next (21st) General Meeting. 4. Nominated candidates for the council ticket for the ballot-form to be submitted to the members of the Association. 5. Received the resolutions of the Pittsburgh section with reference to the circulation of the 50,000 extra copies of the J. D. R., December, 1941 issue to the members of the American Dental Association. 6. Approved limiting the

voting list of the Council to the Council membership from the North American sections for the reference of routine matters only and for the duration of the war. A majority vote is to include at least more than half the membership of the shortened list. 7. Approved the transfer of the funds of the Journal of Dental Research from Richmond Va., to Indianapolis, Ind. 8. Voted to postpone action on the transaction involved in the circulation of the extra copies of the December, 1941, issue of the J. D. R. until the time of the next General Meeting in March, 1943. 9. Received copies of two statements from the members of the Publication Committee and one from President Bodecker with reference to the transaction named in Item 8, just preceding.

Report ordered approved and acts of Council ratified.

Executive Session, Sunday Noon, March 14th. For members of the American Division. Reports of the representatives of the Association to the American Association for the Advancement of Science were received and approved. Representatives and officers were elected for the coming year.

Concluding Executive Session. Sunday afternoon, March 14th. Received reports of Council activities at sessions Saturday night, March 13th and Sunday afternoon, March 14th, as follows: 1. List of twenty-five names reported by the Council as eligible for election to membership. On motion these candidates were unanimously elected to membership (page 235). 2. As provided for in the Constitution the Council recommended that the dues for the coming year be set at $1.00 per member for general purposes plus $4.00 for subscription to the Journal of Dental Research, the latter ($4.00 per member) to be expended for the current expenses of that Journal. On motion this recommendation was adopted unanimously. 3. Received the report of the tellers announcing the election of general officers for the 1943–1944 Association year as printed herewith (page 234). 4. On motion unanimously authorized the Council to approve the budget of the Secretary-treasurer for the disbursal of funds from the general account accruing from the collection of dues at the rate of $1.00 per member. 5. Authorized the Council to act for the Association between meetings and especially to select the time and place of the next general meeting. 6. Passed an unanimous vote of appreciation of the services which helped in the conduct of this general meeting, specifically the staff of the Drake Hotel, the registration and desk service supplied by Dr. Hall's assistants from the University of Indiana, the members of the Chicago Section who operated the projection equipment and Northwestern University for the use of projecting equipment and a typewriter.

After a recess for the dinner the session was assembled jointly with the membership of Omicron Kappa Upsilon, Walter H. Wright presiding, for final exercises and the induction of officers, conducted by Russell W. Bunting for the Research Association.

B. JOURNAL OF DENTAL RESEARCH

(A). *Board of Editors.* The Board of Editors met with members of the Council on March 14, 1943. The question of distribution of the December 1941 issue was discussed. A resolution passed by the Pittsburgh section which protested the action of the Publication Committee was presented and the method of distribution of the particular issue was given by the Publication Committee.

A statement was approved, by those present, for submission to the Board of Editors as a whole. This statement, prepared by J. L. T. Appleton as Chairman of a special committee of the Board of Editors, will be published if approved by the Board of Editors. (B). *Publication Committee.* The growth of the Journal, in material published and in number of subscribers, continues. Although there were fewer pages in the 1942 volume, the total material published would have occupied more space, on the old format, than any volume in the past ten years. This new format saves paper, reduces cost of publication per paper and presents easily read type conforming with many other scientific publications. The 63 papers published were from 27 American universities, the National Institute of Health, U. S. Naval Dental School, Army Medical Museum, 4 unaffiliated authors and 1 foreign university. The number of paid subscribers in 1942 was 1400, compared with 1097 in 1941, 773 in 1940, and 425 in 1937. The cost of publication of Volume 21 was $7003.42.

C. WILLIAM J. GIES ENDOWMENT FUND, JOURNAL OF DENTAL RESEARCH

*Financial statement as of March 12, 1943**

Compiled by L. M. Waugh, Treasurer

This Fund was created, on the initiative of the voluntary Committee on Endowment—organized in New York City in 1937—to insure the continuance of the *Journal* of *Dental Research* "in full accord with the highest ideals of strictly professional journalism devoted to the advancement of research," to which the *Journal* was dedicated at its establishment in 1919.

I. Amounts received from organizations (March 14, 1942–March 12, 1943)

Alpha Omega Fraternity (continuing annual payment)	$50.00	
American College of Dentists: New York Section	100.00	
Illinois State Dental Society (completing pledge of $1500)	300.00	
International Association for Dental Research: Boston Section	25.00	
Michigan State Dental Society (completing pledge of $500)	250.00	
Ohio State Dental Society (including annual payment of $60)	160.00	
Pierre Fauchard Academy	25.00	
Virginia State Dental Association	50.56	
		$960.56

II. Amounts received from individuals (March 14, 1942–March 12, 1943)

$110: G. C. Paffenbarger (part of pledged total)	$110.00	
$100: Oren A. Oliver	100.00	
$50: C. H. Schott	50.00	
$20: A. R. Cooke	20.00	
$10: F. C. Bell, J. F. Blakemore, M. D. Gibbs, M. H. Gray, S. F. Hirsch, J. D. Jordan, S. P. Rushing (7 × $10)	70.00	
$6.75: F. A. Richmond (interest on bond; Section III, below)	6.75	
$5: A. J. Asgis, J. P. Buckley, F. W. Meacham, Charles Nelson, C. H. Schuyler (5 × $5)	25.00	
$2: I. P. Muzzey	2.00	383.75
Total cash receipts: March 14, 1942 to March 12, 1943		$1,344.31

* The report for March 14, 1942, appeared in the *J. Den. Res.*, **21**: 346, 1942. A consolidated report, from the beginning of the Fund to and including March 14, 1942, was published in the *J. Amer. Col. Den.*, **9**: 436, 1942.

III. Current accreditation of receipts (assets) not previously reported

In 1937, Fred A. Richmond contributed a first mortgage bond for $100 on the Bethany Methodist Hospital, Kansas City, Mo., bearing interest at 4.5 percent, payable semi-annually. Heretofore, only the interest was credited.**	100.00
In 1939, Don J. Aubertine contributed a number of shares of common stock in the Farnsworth Television and Radio Corporation, incorporated under the laws of the State of Delaware. These were not listed as an asset because they then had no cash value. The original certificate has been exchanged for a 46-share temporary certificate which we now hold. On March 11, 1943, our accountant found that the market value was $7 per share; they are now listed as having a total current value of $322.*** The temporary certificate, #TL 818, is recorded to the credit of the Journal of Dental Research Endowment Fund	322.00
Total	$422.00

IV. Interest income and expense (current year)

Earned interest on cash balances	$112.19
Expenses: none recorded	—
Balance added to the Fund	$112.19

V. Summary of total receipts (assets): 1937–43

Total receipts for the Fund, as of March 14, 1942		$30,854.49
Paid for forty War Bonds	$29,600.00	
Balance on deposit	1,254.49	
Receipts in 1942–43:		
From organizations (Sec. I)		960.56
From individuals (Sec. II)		383.75
Mortgage Bond ($100), Bethany Methodist Hospital (Sec. III)		100.00
Farnsworth Television and Radio Corporation stock (Sec. III)		322.00
Interest on bank deposits (Sec. IV)		112.19
		$32,732.99
Payments for forty-two War Bonds (Sec. VII)	$31,080.00	
Balance on deposit	1,230.99	
Bond and shares (Sec. III)	422.00	

VI. Cumulative summary of annually recorded items of receipts and expenditures

	Contributions (payments)	*Earned interest*	*Expenses*	*Net receipts*	*Cumulative annual net receipts*
1937–38	$10,652.50	None	$134.06	$10,518.44	$10,518.44
1938–39	4,748.17	None	None	4,748.17	15,266.61
1939–40	5,693.78	None	None	5,693.78	20,960.39
1940–41	5,190.55	$206.78	3.53	5,393.80	26,354.19
1941–42	4,166.35	333.95	None	4,500.30	30,854.49
1942–43	1,766.31†	112.19	None	1,878.50	32,732.99
Totals	$32,217.66	$652.92	$137.59	$32,732.99	

** The total amount of interest already received on Dr. Richmond's contribution of the bond, including the $6.75 recorded in Section II above, is $15.75. Thus his contribution to date is $115.75. The bond matures on May 1, 1947.

*** This brings the total amount of Dr. Aubertine's contribution to the Fund to $342; in a previous report, receipt of $20 had been acknowledged.

† This total includes $422—the total current values of the bond and stock mentioned in Section III.

VII. Statement regarding investment in War Bonds

By authorization of the Trustees of the Association, forty-two War Bonds of Series F ("12-year appreciation bonds"), costing $740 each, have been purchased from the funds in the Endowment Committee's treasury, as of the following dates and serial numbers:

Purchased (10) March 30, 1942: M140400F to M140409F, inclusive	$7,400.00
Purchased (22) May 29, 1942: M197811F to M197832F, inclusive	16,280.00
Purchased (8) July 29, 1942: M237558F to M237565F, inclusive	5,920.00
Purchased (2) December 21, 1942: M423990F and M423991F	1,480.00
Total	$31,080.00††

The payee named on each bond is "Committee on the William J. Gies Endowment Fund for the Journal of Dental Research (an unincorporated body)." All of these War Bonds (and the Bethany Methodist Hospital Bond and Farnsworth Television and Radio Corporation Stock, indicated in Section III) are in the custody of the Treasurer of the Committee, in a safety deposit box, Empire Trust Company, 580 Fifth Ave., New York City, in trust for the Committee.

VIII. Summary of open accounts relating to pledges

1: Organizations

	Pledge	*Paid*	*Balance*	
American College of Dentists	$5,000	$4,000	$1,000	
International College of Dentists	800	200	600	
Kansas: First District Dental Society	100	25	75	
J. B. Mann Study Club, Washington, D. C.	1,000	100	900	$2,575
2: Individuals				
In Memoriam: John and Ophelia E. Gies, Reisterstown, Maryland, 1872 (John Gies III, William J. Gies, II)	$1,000	$800	$200	
Harry Kaplan	250	100	150	
George C. Paffenbarger	250	235	15	
Gordon L. Teall	10	5	5	$370
				$2,945

IX. Correction of the annual report for 1941 (as published in the J. Den. Res.) and of the consolidated reports (1938–42), as published in the J. Amer. Col. Den. (Dec. 1942)

The accreditation of $34 to the "Indiana Dental Association" should have been to the Indiana Section of the American College of Dentists. To that amount should have been added $19 contributed, as members of that Section, by Drs. J. B. Carr, F. V. Hilgemann, L. A. Fonner and R. C. Shurr—a total of $53 for that Section.

D. OFFICERS AND MEMBERS ELECTED

1. HONORARY OFFICERS: Vice-presidents—*R. Gordon Agnew*, Chengtu. *George B. Pritchard*, London. *J. C. Middleton Shaw*, Johannesburg.

2. ACTIVE OFFICERS: President—*Philip Jay*, University of Michigan. President-elect—*J. Trendley Dean*, National Institute of Health. Vice-president—*Wallace D. Armstrong*, University of Minnesota. Secretary-treasurer—*Edward H. Hatton*, Northwestern University. Trustee—*Russell W. Bunting*, University of Michigan. Editor—*Hamilton B. G. Robinson*, Washington University.

†† On March 25, one additional $1,000 War Bond—Series F, M204356F—was purchased, from the balance on deposit, at the terms and on the conditions of those previously obtained, as outlined in this section (VII).

Additional Members of Publication Committee—*J. Frank Hall*, University of Indiana and *Sumpter S. Arnim*, Medical College of Virginia.

3. MEMBERS ELECTED: Bethesda, Md.—*A. Porter S. Sweet*, U. S. Navy, Dental School. Chicago, Ill.—*P. F. Collins. Dan Y. Burrill, Smith Freeman* and *Evelyn B. Tilden* of Northwestern University. Indianapolis, Ind.—*Harry J. Healey* and *G. Thaddeus Gregory*, Indiana University. Memphis, Tenn.—*Marguerite T. Dean* and *Richard D. Dean*, University of Tennessee. Milford, Del.—*Clyde A. Nelson*, Caulk Co. Minneapolis, Minn.—*A. P. Lund, George A. Montelius* and *C. P. Oliver*, University of Minnesota. Mt. Vernon, N. Y.—*E. R. Granger*. New York, N. Y.—*Capt. Clemens V. Rault*, U. S. Navy, and *Gustav Haber*. Rochester, Minn.—*J. A. Milhon*, Mayo Clinic. Rochester, N. Y.—*Peter P. Dale* and *Charles F. Vallotton*, University of Rochester. Praetoria, South Africa—*T. Ockersee*, Department of Health. San Francisco, Cal.—*James Nuckols*, University of California. Toledo, Ohio—*E. J. Molnar*, Ransom and Randolph. Washington, D. C.—*R. Lewis Hayes* and *V. H. Powell*, Howard University. *N. B. Williams*, U. S. Army Dental School.

E. MEMBERS VOTING AT ANNUAL SESSION

Ballots were received from the following:

Aisenberg, Anderson (B. G.), Applebaum, Appleton, Archer, Arnim, Arnold, Armstrong, Asher, Austin, Bauer, Bear, Becks, Bodecker, Bossert, Boucher, Brand, Brandhorst, Brawley, Breitner, Brekhus, Broadbent, Brodsky, Bryan, Bunting, Burkett, Canby, Carr, Chase, Cheyne, Clough, Cohen, Coolidge, Coy, Crawford, Darlington, Dean, Deatherage, Dobbs, Dunning (W. B.), Easlik, Edwards (L. F.), Edwards (R. W.), Ehrich, Elliott (F. C.), Elvove, Ennis, Epstein (Sidney), Erickson, Fairbank, Fee, Figg, Fleming, Forbes, Fraser, Gabel, Gafafer, Glickman, Goldman, Gottlieb, Grossman, Hadley, Hahn, Hall, Hatton, Hellman, Higley, Hodge, Hooper, Jasper, Jay, Johnson, Jump, Kaiser, Karshan, Keilty, Kelsey, Kern, Kesel, Keys, Kimball, Kitchin, Klaffenbach, Kniesner, Knighton, Krogh, Koch, Kotanyi, Krasnow, Lalonde, Lasater, Lasby, Lefkowitz, Lischer, Lowery (P. C.), Lundquist, Lyons, McCauley, McClure, Main, Manly, Margolis, Massler, Mead, Merkeley, Miller (H. A.), Miner, Moore (G. R.), Moore (Mary), Moore (T. E.), Mueller (A. H.), Myers, Neuwirth, Newman, Noyes (F. B.), Oblatt, Oliver, Orban, Peyton, Phillips, Rabkin, Radusch, Randall (W. M.), Rittershofer, Robinson (H. B. G.), Romnes, Rosenthal, Salzman, Scheu, Schour, Shell, Simon, Simmonds, Skinner, Sorrin, Souder, Spangenberg, Spector, Speidel, Stafne, Steadman, Stillman, Taylor (Edward), Teuscher, Thoma, Thomas (B. O. A.), Thompson (H. S.), Van Huysen, Volland, Wach, Wainwright, Waldron, Ward, Wasserman, Wesson, Wheeler, Willett, Weinmann, Willman, Yates, Zander, Ziskin, Total, 162.

F. MEMBERS IN ATTENDANCE AT ONE OR MORE SESSIONS, LISTED BY SECTIONS

Ann Arbor—Bunting, Jay, Peyton, Ward. *Boston*—Bibby, Deakins, Miner, Volker, Zander. *Chicago*—Asher, Blackwell, Blayney, Boulger, Bradel, Brodie, Coolidge, Denton, Fosdick, Freeman, Harrison, Hatch, Hatton, Hemmens, Hine, Johnson, Jump, Kern, Kesel, Lasater, Logan, Lundquist, Majerison, A. H. Mueller, F. B. Noyes, H. J. Noyes, Nylander, Orban, Pendleton, Romnes, Schour, Schram, Shell, Skillen, Skinner, Stephan, Teuscher, Tylman, Wassermann, Wessinger. *Cleveland*—Hill, Wylie. *Columbus*—Kitchen, Spangenberg. *Indianapolis*—Cheyne, Crawford, Hall, Phillips, Speidel, Van Huysen. *Iowa City*—Bryan. *Louisville*—Myers, O'Rourke. *Minnesota*—Brekhus, Lasby, Radusch, Simon, Waldron. *New York*—Bodecker, Gies, Holliday, Lefkowitz, Leonard, S. C. Miller, Waugh. *Pittsburg*—Cox, Van Kirk, Wright. *Richmond*—Arnim, Bear. *Rochester*—Hodge, McCauley. *San Francisco*—Fleming, Sloman, Tainter. *St. Louis*—Bauer, Boling, Lischer, Purcell, Robinson. *Non-attached*—Manly. Total, 90.